IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WISCONSIN

LG ELECTRONICS, INC.,

Plaintiff,

v.

QUANTA COMPUTER INC., QUANTA STORAGE INC., and QUANTA COMPUTER USA, INC.,

Defendants.

CIV. ACTION NO. 07 C 0361

DEMAND FOR JURY TRIAL

FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff, LG Electronics, Inc. ("LGE"), files this amended complaint for patent infringement against defendants, Quanta Computer Inc. ("Quanta"), Quanta Storage Inc. ("QSI") and Quanta Computer USA, Inc. ("Quanta USA") and alleges as follows:

PARTIES

1. Plaintiff LGE is a corporation organized under the laws of the Republic of Korea with its principal place of business in Seoul, Korea. LGE designs, makes, and sells many different products world-wide for consumer use including mobile telephone handsets, plasma displays, washing machines, and, most relevant here, Digital Versatile Disc ("DVD") recorders and players. LGE is the owner of record of the patents involved in this action.

2. Defendant Quanta is a Taiwanese corporation which has an office at No. 211 Hwa 2nd Road, Kuei Shen Hsiang, Tao Yuan Shien, Taiwan, R.O.C. Quanta is a manufacturer and distributor of, among other things, computer systems including DVD drives, and sells them within the United States. On information and belief, Quanta owns and controls Quanta

Manufacturing Nashville LLC, directly or through intermediaries, which is based in Nashville, Tennessee, and which manufactures, repairs and distributes computer systems.

3. Defendant QSI is a Taiwanese corporation which has an office at No. 188 Wen Hwa 2nd Road, Kuei Shen Hsiang, Tao Yuan Shien, Taiwan, R.O.C. QSI is a manufacturer and/or seller of, among other things, DVD drives for use in computer systems, and ships or causes them to be shipped to the United States. On information and belief, defendant Quanta partially owns and controls defendant QSI, directly or through intermediaries.

4. Defendant Quanta USA is a California corporation which has an office at 45630 Northpore Loop, East Fremont, CA 94538. On information and belief, Quanta wholly owns and controls defendant Quanta USA, directly or through intermediaries. On information and belief, Quanta USA is a distributor of, among other things, DVD drives and/or computer systems containing DVD drives, and sells them within the United States. Further, upon information and belief, Quanta USA uses, repairs and/or reconstructs, among other things, DVD drives and/or computers systems containing DVD drives, at its factories in California. Quanta, QSI and Quanta USA are referred to herein collectively as "Defendants."

JURISDICTION AND VENUE

5. This is an action for patent infringement arising under the patent laws of the United States, including 35 U.S.C. § 271. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a) because this action arises under the patent laws of the United States, including 35 U.S.C. § 271 *et seq*.

6. The Court has personal jurisdiction over Defendants because Defendants have established minimum contacts with the forum and the exercise of jurisdiction over Defendants would not offend traditional notions of fair play and substantial justice. On information and belief, Defendants knowingly and intentionally participate in a stream of commerce between

Taiwan and the United States, including a portion of such stream going from Taiwan to the Western District of Wisconsin, such stream of commerce including DVD drives and computer systems containing DVD drives (hereinafter the "accused products") that embody the system, practice the method, and/or produce the product covered by one or more claims of patents owned by LGE, as asserted in greater detail hereinafter. Defendants manufacture such devices and/or components thereof, and cause them to be shipped to the United States. Defendants import such devices, or cause them to be imported, into the United States, and then said devices were and are sold and offered for sale in the United States, including to customers in the Western District of Wisconsin, to the injury of the plaintiff, in this district, and in violation of the United States patent laws, described in more detail hereinafter.

7. The Defendants have obtained financial gain from their trafficking in the accused products. The Defendants have sought and obtained a benefit from sales of such products in this district, and have sought and obtained the benefits of the protection of Wisconsin law. In accordance with established distribution channels for the accused products, the Defendants reasonably anticipated that some of such products would end up in this district and be sold therein.

8. Venue is proper in this district pursuant to 28 U.S.C. §§ 1391(b), (c) and 1400(b).

COUNT I - FIRST CLAIM FOR RELIEF AGAINST ALL DEFENDANTS (INFRINGEMENT OF U.S. PATENT NO. 7,088,655)

9. LGE realleges and incorporates by reference the allegations of paragraphs 1-8.

10. LGE is the sole owner of U.S. Patent No. 7,088,655, titled "Method and Apparatus for Establishing Manufacturer-Specific Test Writing Parameters for Writing of Writable Optical Storage Media" ("the '655 patent"). The '655 patent was duly and legally

issued on August 6, 2006 by the United States Patent and Trademark Office ("USPTO") to LGE. A true and correct copy of the '655 patent is attached to this Complaint as Exhibit A.

11. The Defendants have appropriated the invention and sell DVD drives and/or computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '655 patent as part of their normal and intended operation, including without limitation the following: DVD drives that comply with industry DVD standards, including without limitation QSI SDW-082, SDW-042, SDW-085, SDW-086, SDW-86K, SDW-087, SDW-087D, SDW-087F, SDW-087I, SDW-087L, SDW-087S, and TDW-081 drives and/or computer systems containing DVD drives that comply with industry DVD standards, including but not limited to notebook computers ultimately sold as HP Pavilion dv9000 series, dv6000 series, dv2000 series, and tx1000 series. The Defendants have been and still are infringing, contributing to the infringement of, and/or actively inducing infringement of the '655 patent by, among other things, doing the following things:

a. making or causing to be made DVD drives and/or computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '655 patent as part of their normal and intended operation, shipping such devices, or causing them to be shipped, to the United States, and importing such devices, or causing them to be imported, into the United States, in violation of 35 U.S.C. § 271(a);

b. offering to sell and selling such devices, or causing them to be offered for sale and sold, in the United States, including, without limitation, in this district, in violation of 35 U.S.C. § 271(a);

c. contributing to infringement of the '655 patent by selling such devices, knowing them to be specially adapted for practicing the patented invention and not a staple article or commodity of commerce suitable for substantial noninfringing use, and knowing of the '655 patent, in violation of 35 U.S.C. § 271(c);

d. actively inducing infringement of the '655 patent by knowingly selling such devices, and in advertising and promotional materials knowingly advising and urging customers to use the patented invention, in violation of 35 U.S.C. § 271(b); and

e. aiding and abetting other persons to infringe and cause infringement of the '655 patent.

12. Such infringement has injured and damaged LGE. Unless enjoined by this Court, the Defendants will continue their infringement, irreparably injuring LGE.

COUNT II - SECOND CLAIM FOR RELIEF AGAINST ALL DEFENDANTS (INFRINGEMENT OF U.S. PATENT NO. 6,782,488)

13. LGE realleges and incorporates by reference the allegations of paragraphs 1-12.

14. LGE is the sole owner of U.S. Patent No. 6,782,488, titled "Method and Apparatus of Recording Data in the Optical Recording Medium" ("the '488 patent"). The '488 patent was duly and legally issued on August 24, 2004 by the USPTO to LGE. A true and correct copy of the '488 patent is attached to this Complaint as Exhibit B.

15. The Defendants have appropriated the invention and sell DVD drives and/or computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '488 patent as part of their normal and intended operation, including without limitation the following: DVD drives that comply with the DVD-RAM standard, including without limitation QSI SDW-086, SDW-86K, SDW-087, SDW-087D, SDW-087F, SDW-087I, SDW-087L, SDW-087S, and TDW-081 drives, and/or computer systems

containing a DVD drive that supports the DVD-RAM standard, including but not limited to notebook computers ultimately sold as HP Pavilion dv9000 series, dv6000 series, dv2000 series, and tx1000 series. The Defendants have been and still are infringing, contributing to the infringement of, and/or actively inducing infringement of the '488 patent by, among other things, doing the following things:

a. making or causing to be made DVD drives and/or computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '488 patent as part of their normal and intended operation, shipping such devices, or causing them to be shipped, to the United States, and importing such devices, or causing them to be imported, into the United States, in violation of 35 U.S.C. § 271(a);

b. offering to sell and selling such devices, or causing them to be offered for sale and sold, in the United States, including, without limitation, in this district, in violation of 35 U.S.C. § 271(a);

c. contributing to infringement of the '488 patent by selling such devices, knowing them to be specially adapted for practicing the patented invention and not a staple article or commodity of commerce suitable for substantial noninfringing use, and knowing of the '488 patent, in violation of 35 U.S.C. § 271(c);

d. actively inducing infringement of the '488 patent by knowingly selling such devices, and in advertising and promotional materials knowingly advising and urging customers to use the patented invention, in violation of 35 U.S.C. § 271(b); and

e. aiding and abetting other persons to infringe and cause infringement of the '488 patent.

16. Such infringement has injured and damaged LGE. Unless enjoined by this Court, the Defendants will continue their infringement, irreparably injuring LGE.

COUNT III - THIRD CLAIM FOR RELIEF AGAINST QUANTA AND QUANTA USA (INFRINGEMENT OF U.S. REISSUED PATENT NO. 38,868)

17. LGE realleges and incorporates by reference the allegations of paragraphs 1-16.

18. LGE is the sole owner of U.S. Reissued Patent No. RE38,868, titled "Apparatus and Method for Controlling Recording and Reproduction in Digital Video Cassette Tape Recorder" ("the '868 patent"). The '868 patent was duly and legally issued on November 8, 2005 by the USPTO to LGE. A true and correct copy of the '868 patent is attached to this Complaint as Exhibit C.

19. Quanta and Quanta USA have appropriated the invention and sell computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '868 patent as part of their normal and intended operation, including without limitation the following: computer systems containing DVD burning or player software and DVD drives that comply with industry DVD standards, including but not limited to notebook computers ultimately sold as HP Pavilion dv9000 series, dv6000 series, dv2000 series, and tx1000 series. Quanta and Quanta USA have been and still are infringing, contributing to the infringement of, and/or actively inducing infringement of the '868 patent by, among other things, doing the following things:

a. making or causing to be made computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '868 patent as part of their normal and intended operation, shipping such devices, or causing them to be shipped, to the United States, and importing such devices, or causing them to be imported, into the United States, in violation of 35 U.S.C. § 271(a);

b. offering to sell and selling such devices, or causing them to be offered for sale and sold, in the United States, including, without limitation, in this district, in violation of 35 U.S.C. § 271(a);

c. contributing to infringement of the '868 patent by selling such devices, knowing them to be specially adapted for practicing the patented invention and not a staple article or commodity of commerce suitable for substantial noninfringing use, and knowing of the '868 patent, in violation of 35 U.S.C. § 271(c);

d. actively inducing infringement of the '868 patent by knowingly selling such devices, and in advertising and promotional materials knowingly advising and urging customers to use the patented invention, in violation of 35 U.S.C. § 271(b); and

e. aiding and abetting other persons to infringe and cause infringement of the '868 patent.

20. Such infringement has injured and damaged LGE. Unless enjoined by this Court, Quanta and Quanta USA will continue their infringement, irreparably injuring LGE.

COUNT IV – FOURTH CLAIM FOR RELIEF AGAINST QUANTA AND QUANTA USA (INFRINGEMENT OF U.S. REISSUED PATENT NO. 37,052)

21. LGE realleges and incorporates by reference the allegations of paragraphs 1-20.

22. LGE is the sole owner of U.S. Reissued Patent No. RE37,052, titled "Copy Prevention Method and Apparatus of a Digital Recording/Reproducing System Employing a Marker Including Copy Protection Information and Code Data for Descrambling" ("the '052 patent"). The '052 patent was duly and legally issued on February 13, 2001 by the USPTO to LGE. A true and correct copy of the '052 patent is attached to this Complaint as Exhibit D.

23. Quanta and Quanta USA have appropriated the invention and sell computer systems that embody the system, practice the method, and/or produce the product covered by one

or more claims of the '052 patent as part of their normal and intended operation, including without limitation the following: computer systems containing DVD burning or player software and DVD drives that comply with industry DVD standards, including but not limited to notebook computers ultimately sold as HP Pavilion dv9000 series, dv6000 series, dv2000 series, and tx1000 series. Quanta and Quanta USA have been and still are infringing, contributing to the infringement of, and/or actively inducing infringement of the '052 patent by, among other things, doing the following things:

a. making or causing to be made computer systems that embody the system, practice the method, and/or produce the product covered by one or more claims of the '052 patent as part of their normal and intended operation, shipping such devices, or causing them to be shipped, to the United States, and importing such devices, or causing them to be imported, into the United States, in violation of 35 U.S.C. § 271(a);

b. offering to sell and selling such devices, or causing them to be offered for sale and sold, in the United States, including, without limitation, in this district, in violation of 35 U.S.C. § 271(a);

c. contributing to infringement of the '052 patent by selling such devices, knowing them to be specially adapted for practicing the patented invention and not a staple article or commodity of commerce suitable for substantial noninfringing use, and knowing of the '052 patent, in violation of 35 U.S.C. § 271(c);

d. actively inducing infringement of the '052 patent by knowingly selling such devices, and in advertising and promotional materials knowingly advising and urging customers to use the patented invention, in violation of 35 U.S.C. § 271(b); and

e. aiding and abetting other persons to infringe and cause infringement of the '052 patent.

24. Such infringement has injured and damaged LGE. Unless enjoined by this Court, Quanta and Quanta USA will continue their infringement, irreparably injuring LGE.

PRAYER FOR RELIEF

WHEREFORE, LGE prays that the Court enter judgment ordering as follows:

1. adjudicating and declaring that Defendants have infringed, actively induced infringement of, and contributorily infringed the foregoing patents;

2. preliminarily and permanently enjoining the Defendants from further infringement of the foregoing patents by unauthorized use of the inventions patented therein, by defendants and their officers, agents, servants, employees, attorneys and all persons in active concert or participation with them;

3. that Defendants account, and pay actual damages (but no less than a reasonable royalty), to LGE for Defendants' infringement of the foregoing patents;

4. that Defendants pay treble damages to LGE as provided by 35 U.S.C. § 284;

5. that Defendants pay LGE's costs, expenses and prejudgment interest as provided for by 35 U.S.C. § 284;

6. adjudicating and declaring that this case is exceptional within the meaning of 35 U.S.C. § 285 and that LGE should be awarded its reasonable attorneys fees; and

7. granting LGE such other and further relief as the Court deems just and appropriate.

DEMAND FOR JURY TRIAL

Pursuant to Federal Rule of Civil Procedure 38, Plaintiff demands a jury trial on all issues so triable.

Dated: October 16, 2007

Respectfully submitted,

__/s/ John C. Scheller__
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EXHIBIT A

US007088655B2

(12) **United States Patent**
Kim

(10) **Patent No.: US 7,088,655 B2**
(45) **Date of Patent: Aug. 8, 2006**

(54) **METHOD AND APPARATUS FOR ESTABLISHING MANUFACTURER-SPECIFIC TEST WRITING PARAMETERS FOR WRITING OF WRITABLE OPTICAL STORAGE MEDIA**

(75) Inventor: **Jeong Woo Kim**, Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 570 days.

(21) Appl. No.: **10/645,599**

(22) Filed: **Aug. 22, 2003**

(65) **Prior Publication Data**

US 2004/0057361 A1 Mar. 25, 2004

Related U.S. Application Data

(63) Continuation of application No. 09/397,028, filed on Sep. 16, 1999, now Pat. No. 6,646,965.

(30) **Foreign Application Priority Data**

Sep. 18, 1998 (KR) 1998-39128

(51) **Int. Cl.**
G11B 7/00 (2006.01)

(52) **U.S. Cl.** **369/47.53**; 369/47.5; 369/53.1; 369/59.1; 369/116

(58) **Field of Classification Search** ..... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,502,702	A	3/1996	Nakajo	
5,513,166	A *	4/1996	Tokumitsu et al.	369/53.15
5,790,505	A *	8/1998	Abe et al.	369/116
5,978,351	A	11/1999	Spruit et al.	
6,052,347	A	4/2000	Miyata	
6,111,841	A	8/2000	Iida et al.	
6,157,609	A	12/2000	Shoji et al.	

FOREIGN PATENT DOCUMENTS

JP	5-290383	11/1993

* cited by examiner

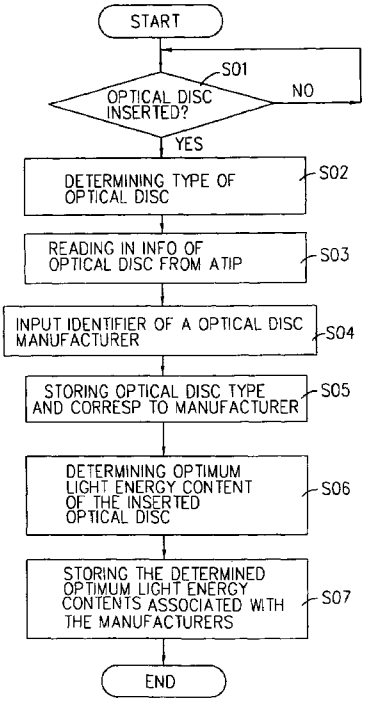
Primary Examiner—Muhammad Edun

(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A method and an apparatus establish manufacturer-specific test writing parameters for writing of a writable optical storage media in accordance with the media manufacturers, which are experimentally determined and stored into a certain storing unit; determine an optimum writing light power based on the determined optimum writing parameters; and write an input signal into the user's data region of the optical disk.

16 Claims, 7 Drawing Sheets



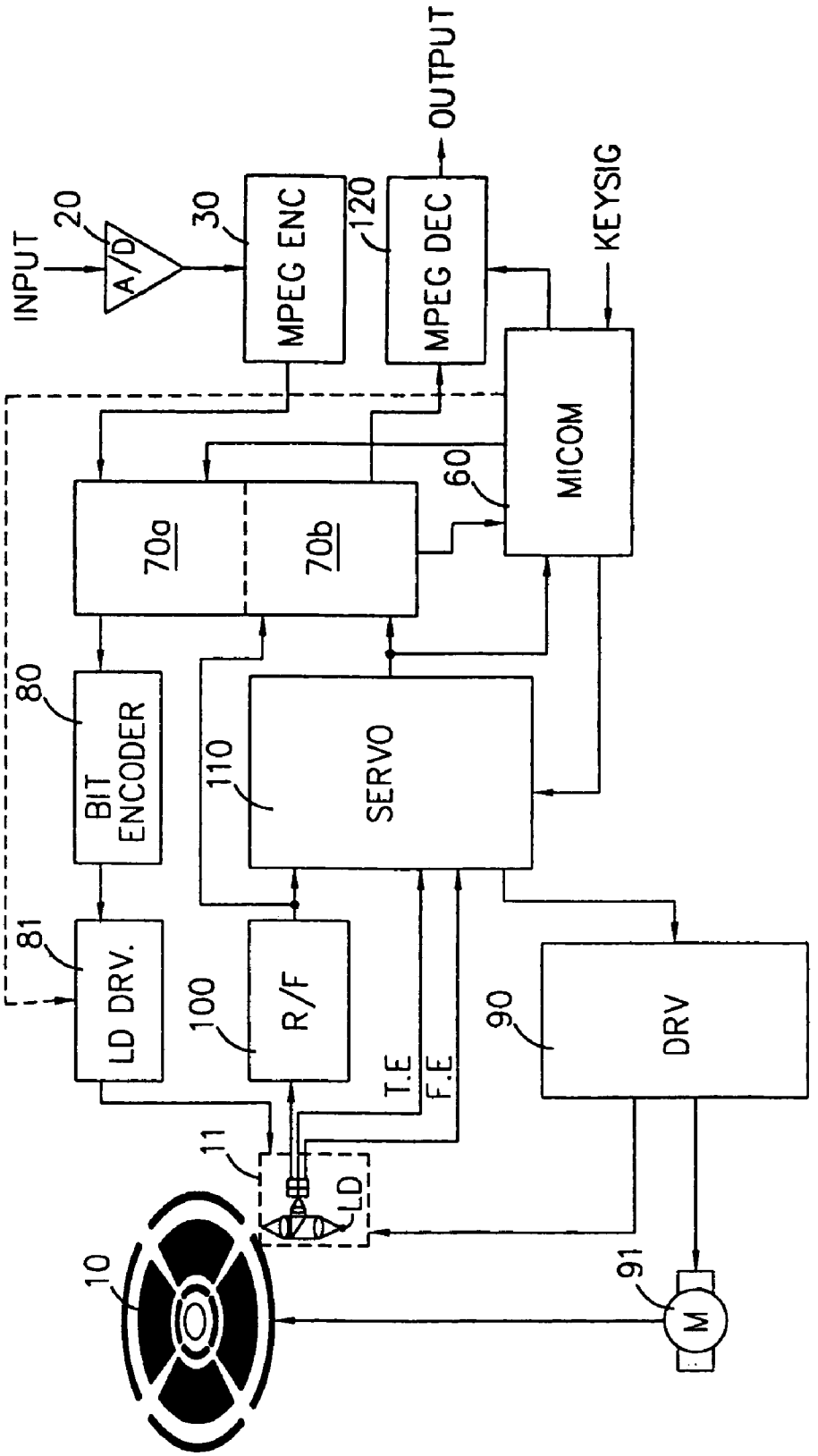
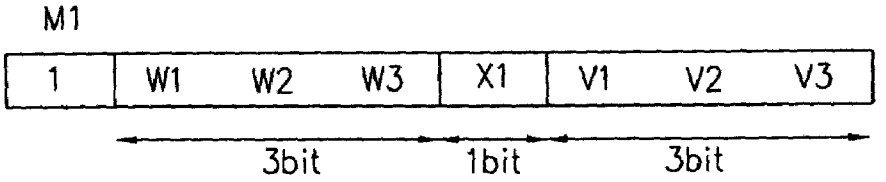


FIG. 1
CONVENTIONAL ART

FIG. 2
CONVENTIONAL ART



W1,W2,W3 =000 ---→ P_{ind} =5mw
=001 ---→ P_{ind} =6mw
=010 ---→ P_{ind} =7mw
=011 ---→ P_{ind} =8mw
=100 ---→ P_{ind} =9mw
=101 ---→ P_{ind} =10mw
=110 ---→ P_{ind} =11mw
=111 ---→ P_{ind} =12mw

FIG. 3
CONVENTIONAL ART

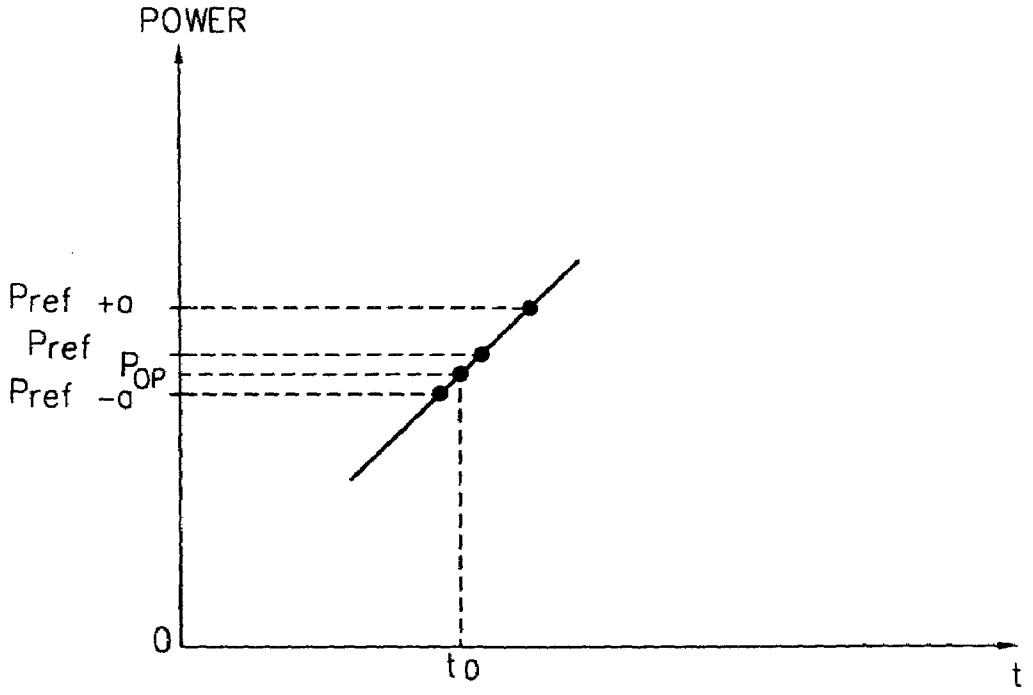


FIG. 4A
CONVENTIONAL ART

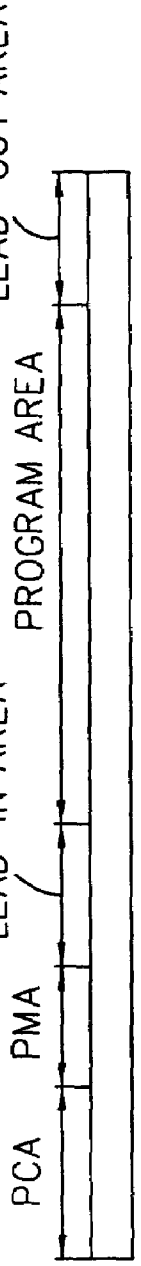


FIG. 4B
CONVENTIONAL ART

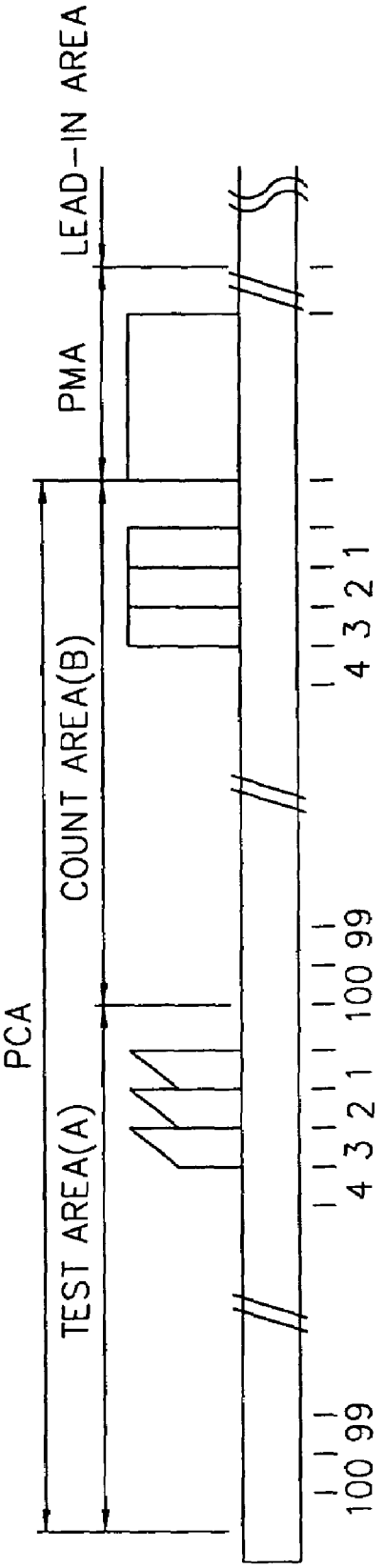


FIG. 5

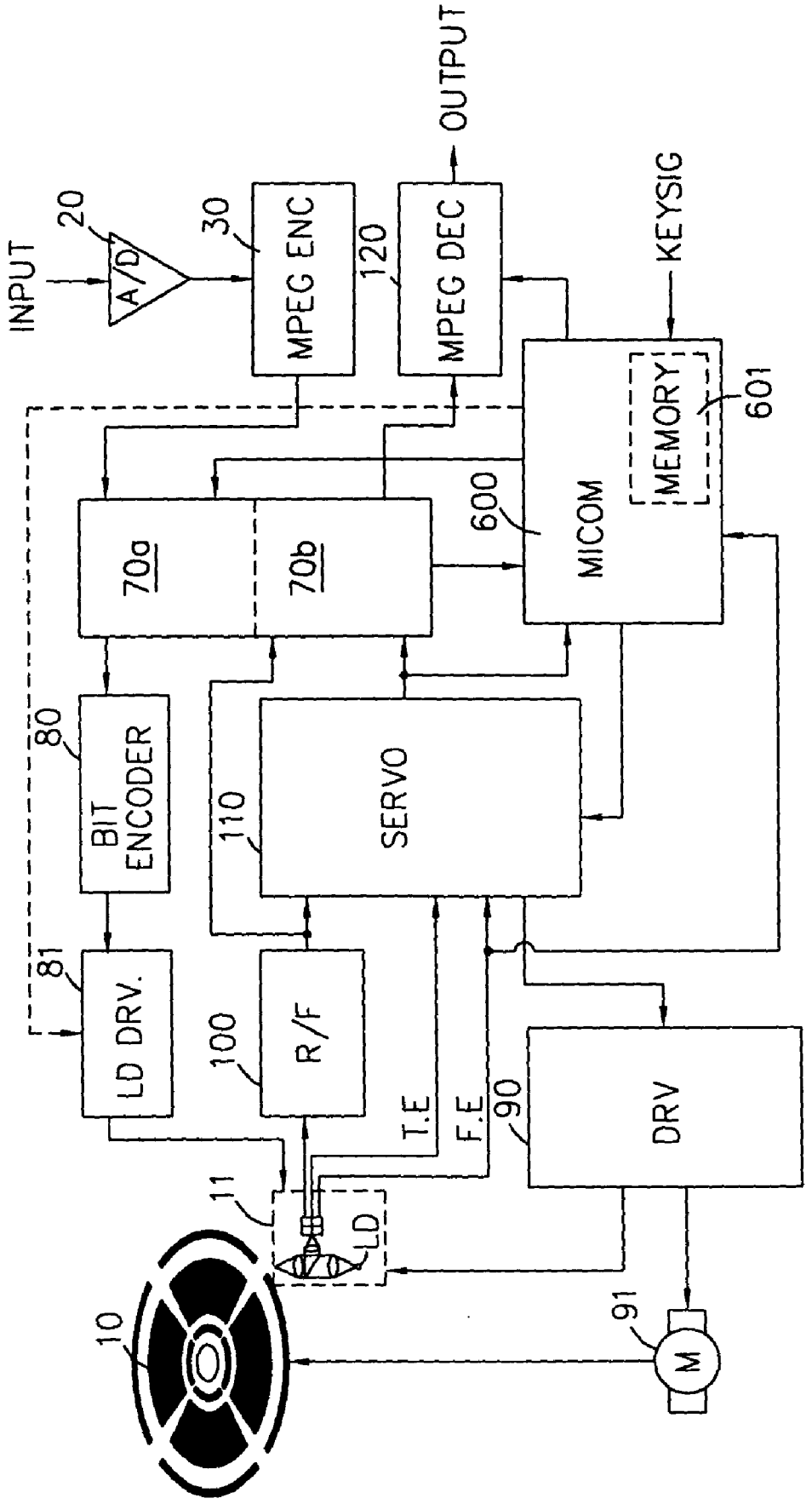

INPUT
20
A/D
30
MPEG ENC
120
MPEG DEC
OUTPUT
KEYSIG
MEMORY
601
MICOM
600
70a
70b
80
BIT ENCODER
110
SERVO
81
LD DRV.
100
R/F
T.E
F.E
90
DRV
11
LD
10
91
M

FIG. 6

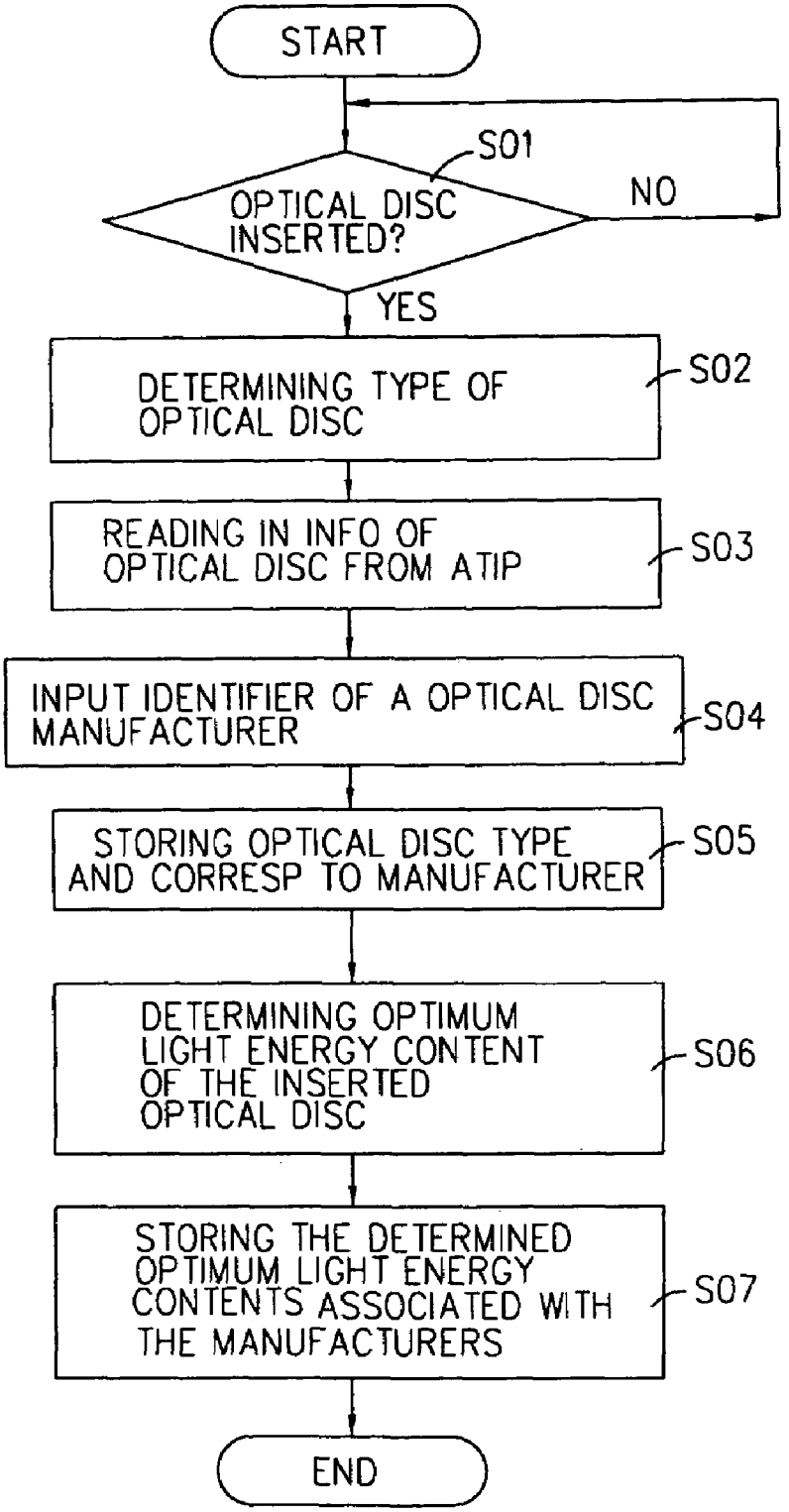

START
S01
OPTICAL DISC INSERTED?
NO
YES
DETERMINING TYPE OF OPTICAL DISC
S02
READING IN INFO OF OPTICAL DISC FROM ATIP
S03
INPUT IDENTIFIER OF A OPTICAL DISC MANUFACTURER
S04
STORING OPTICAL DISC TYPE AND CORRESP TO MANUFACTURER
S05
DETERMINING OPTIMUM LIGHT ENERGY CONTENT OF THE INSERTED OPTICAL DISC
S06
STORING THE DETERMINED OPTIMUM LIGHT ENERGY CONTENTS ASSOCIATED WITH THE MANUFACTURERS
S07
END

FIG. 7

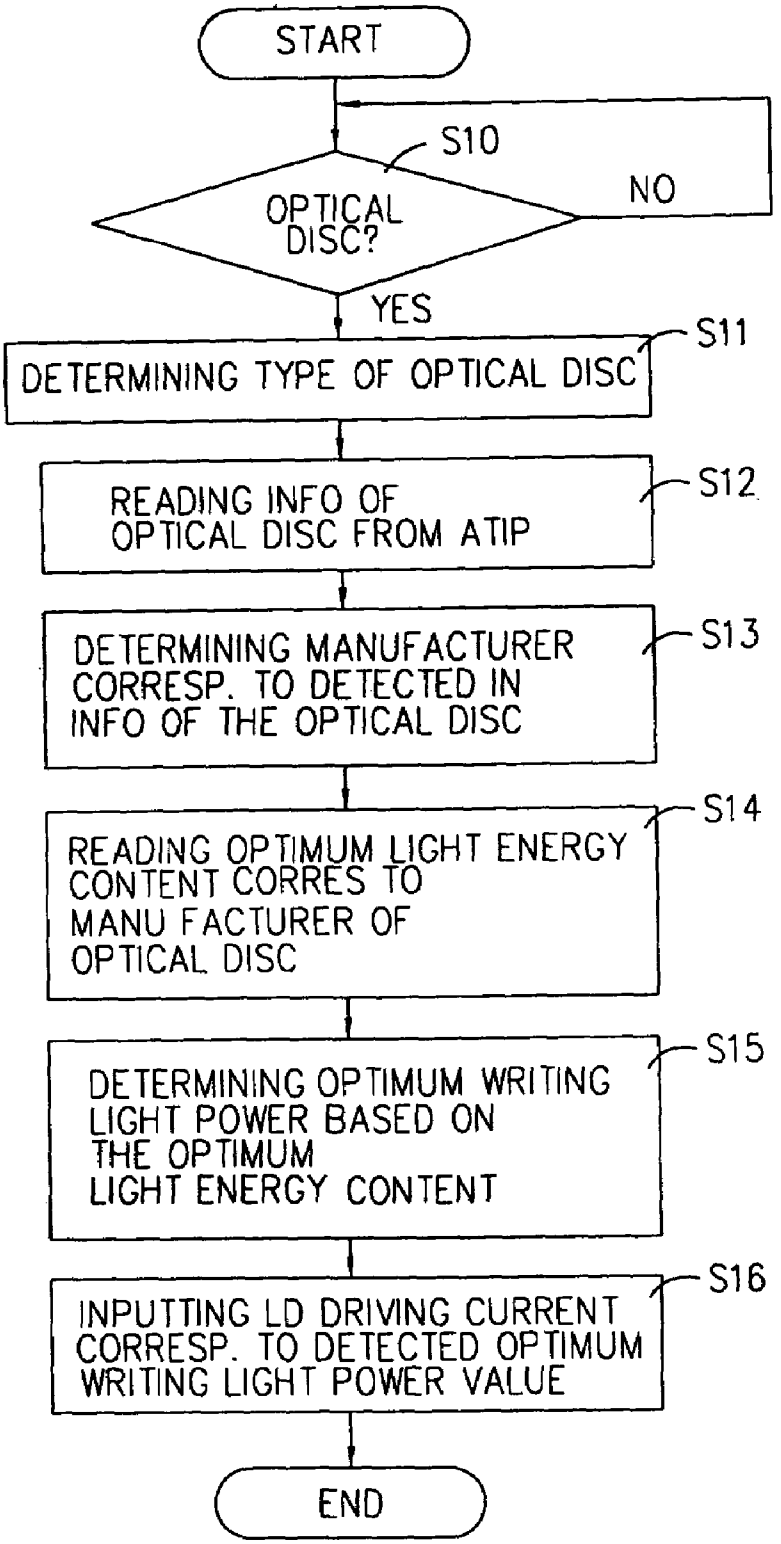
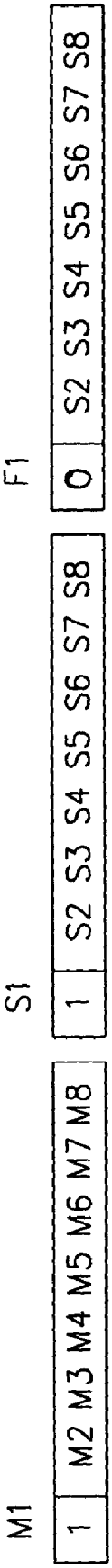
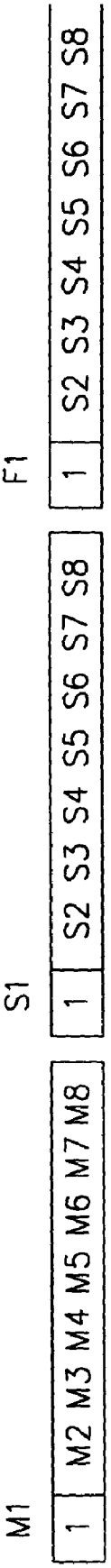

START
S10
OPTICAL DISC?
NO
YES
S11
DETERMINING TYPE OF OPTICAL DISC
S12
READING INFO OF OPTICAL DISC FROM ATIP
S13
DETERMINING MANUFACTURER CORRESP. TO DETECTED IN INFO OF THE OPTICAL DISC
S14
READING OPTIMUM LIGHT ENERGY CONTENT CORRES TO MANU FACTURER OF OPTICAL DISC
S15
DETERMINING OPTIMUM WRITING LIGHT POWER BASED ON THE OPTIMUM LIGHT ENERGY CONTENT
S16
INPUTTING LD DRIVING CURRENT CORRESP. TO DETECTED OPTIMUM WRITING LIGHT POWER VALUE
END

FIG. 8A



EXAMPLE1. : M1M2...M8 S1S2...S8 F1F2...F8 = 10010111 01001001 00000000
= 97 : 49 : 00

FIG. 8B



EXAMPLE2. : M1M2...M8 S1S2...S8 F1F2...F8 = 01110000 01000101 00010101
= 70 : 45 : 15

METHOD AND APPARATUS FOR ESTABLISHING MANUFACTURER-SPECIFIC TEST WRITING PARAMETERS FOR WRITING OF WRITABLE OPTICAL STORAGE MEDIA

This application is a Continuation of application Ser. No. 09/397,028, filed on Sep. 16, 1999, now U.S. Pat. No. 6,646,965 B1, issued on Nov. 11, 2003, and for which priority is claimed under 35 U.S.C. § 120; and this application claims priority of Application No. 39128/1998 filed in Korea on Sep. 18, 1998 under 35 U.S.C. § 119; the entire contents of all are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a recording/reproducing apparatus for a writable optical storage medium, and in particular to the optimization of writing parameters (for example, a writing light power, writing beam profile (or, writing strategy)) for writing of a writable optical storage medium, based on experimentally determined optimum test writing parameter for the writable optical storage medium according to the manufacturer thereof, by associating data indicative of the manufacturer of a writable optical storage medium and optimum test writing parameters corresponding to the medium manufacturer, and prior to writing an input signal into a writable optical storage medium, judging the medium manufacturer corresponding to a writable optical storage medium, setting the optimum test writing parameters corresponding thereto, and accordingly determining optimum writing parameters for the medium based by performing an optimization produce employing the thusly set optimum test writing parameters.

2. Description of the Background Art

FIG. **1** illustrates the construction of a conventional writable optical storage medium recording/reproducing apparatus which includes an AND converter **20** converting an inputted analog signal into a digital signal, a MPEG encoder **30** encoding the digital signal from the A/D converter **20** into a MPEG format signal, a digital writing signal processing unit **70***a* converting the encoded signal into a writable format by adding an error correction code (ECC), channel bit encoder **80** for converting the signal converted into a writable format into a bit stream, a LC (Laser Diode) driving unit **81** receiving the signal from the channel bit encoder **80** and outputting an optical content driving signal, a pick-up unit **11** writing the input signal into the writable optical storage medium **10** or detecting the written signal in accordance with the optical content driving signal, a drive unit **90** driving the pick-up unit **11** and a spindle motor **91**, an R/F unit **100** receiving a signal detected by the pick-up unit **11** and a spindle motor **91**, an R/F unit **100** receiving a signal detected by the pick-up unit **11** and outputting a filtered and shaped signal, a servo unit **110** controlling the driving operation of the drive unit **90** based on a tracking error signal TE of the pick-up unit **11**, a focus error signal FE, and a rotation of the writable optical storage medium **10** and detecting a synchronous state of the output signal from the R/F unit **100**, a digital reproducing signal processing unit **70***b* recovering a compression write data from the filtered and shaped signal based on the detected synchronous signal, an MPEG decoder **120** decoding the compressed data, converting it into a video and audio signal and outputting the same, and a microcomputer **60** controlling the operations of the recording/reproducing apparatus.

The operation of the writable optical storage medium recording/reproducing apparatus will be explained with reference to the accompanying drawings.

First, when a signal KEYSIG is inputted into the microcomputer **60** requesting a writing operation of an inputted signal INPUT applied to the input terminal, the microcomputer **60** controls the pick-up unit **11** via the servo unit **110** and the drive unit **90** so that a writing light power value P_{ind} written on the writable optical storage medium **10** is read-out before the input signal INPUT is written into the writable optical storage medium. In the case that the writable optical storage medium **10** is a rewritable medium such as a compact disc rewritable (CD-RW), as shown in FIG. **2**, the writing light power value P_{ind} is written in a data form of 3 bits W**1**, W**2** and W**3** at a M1 information byte of a special information field in an Absolute Time In Pre-Groove (ATIP) signal format of a lead-in region of the writable optical storage medium **10**.

When the light power value P_{ind} is read out from the data W**1**, W**2** and W**3**, the microcomputer **60** outputs test digital data (for example, 101010 . . .) to the channel bit encoder **80** via the digital writing signal processing unit **70***a*, and the channel bit encoder **80** converts the digital bit stream outputted from the digital writing signal processing unit **70***a* into a signal format for writing into the writable optical storage medium **10** and then applies the converted signals to the LD driving unit **81**.

As shown in FIG. **3**, the microcomputer **60** variably applies an adjusting signal to the LD driving unit **81** so that the magnitude of the light power value is changed in a certain range of P_{ref+a}, P_{ref-a} based on a reference writing light power (for example, P_{ref}=8 mW) generated by the writing light power value P_{ind}. The LD driving unit **81** outputs a test digital data based on the optical driving current corresponding to the adjusting signal, and the pick-up unit **11** writes the test digital data into the test writing region of the writable optical storage medium **10**. Here, in the case that the loaded writable optical storage medium **10** is a rewritable medium such as a CD-RW, as shown in FIG. **4**A, the test writing region is formed in the PCA (Power Calibration Area). In particular, as shown in FIG. **4**B, the microcomputer **60** causes the test digital data to be written into the test writing region of the rewritble optical storage medium and writes a certain information into the count region B of the PCA region so that the written number of the test digital data is recognized by controlling the pick-up unit **11**.

As the LD driving current is gradually varied, in a state that the test digital data is written in the test region A and the written number of data in the region A is written in the count region B of the PCA of the writable optical storage medium **10**, the microcomputer **60** controls the pick-up unit **11**, and the pick-up unit **11** reads out the test data written in the test region of the PCA region. The microcomputer **60** causes the R/F unit **100** to filter and shape the reproduced signal read-out by the pick-up unit **11** and continuously detects the jitter amount of the clock signal which is phase-synchronized to the reproducing signal by the servo unit **110**. The microcomputer **60** detects an optimum writing light power (in FIG. **3**, P_{op}) by which the test digital data is written at the time when the minimum jitter amount is detected from the clock signals.

When the optimum writing light power P_{op} is determined, an analog signal such as an externally inputted video or audio signal is inputted into the A/D converter **20** for a writing operation at the writable optical storage medium **10**. In this state, the A/D converter **20** converts the inputted

signal into a digital signal, and the MPEG encoder **30** encodes the digital signal based on the MPEG method. The digital writing signal processing unit **70***a* generates an error correction code (ECC) block by adding an encoding and error correction parity to the encoded signal in order to enhance reliability when writing the encoded signal into a writable optical storage medium **10** and output the generated code to the channel bit encoder **80**. The channel bit encoder **80** converts the digital bit stream data outputted from the digital writing signal processing unit **70***a* into a pulse width-modulated signal format for being written into a writable optical storage medium **10**.

Therefore, the microcomputer **60** controls the LD driving unit **81** using an optimum light driving current so that the pulse width-modulated signal is written into the writable optical storage medium **10** based on the optimum writing light power detected during the above-described operation. The LD driving unit **81** applies the pulse width-modulated signal to the pick-up unit **11** based on the optimum light driving current, and the pulse width-modulated signal is written in a users data recording region of the writable optical storage medium **10**.

However, in the case that an optimum writing light power is detected, and an input signal is written, a certain light power deviation occurs between the writable optical storage medium fabrication apparatus and the recording/reproducing apparatus, which writes an input signal into the writable optical storage medium and reproduces the signal therefrom, due to a circuit characteristic and a writable optical storage medium characteristic in the system. For example, a certain deviation may occur between a reference light power adapted to the writable optical storage medium in view of the writable optical storage medium fabrication apparatus and the reference light power for determining a writing light power of the writable optical storage medium in view of each recording/reproducing apparatus. The reference light power adapted under the optimum writing condition when fabricating the writable optical storage medium may not correspond to the reference light power which provides the optimum writing conditions for the recording/reproducing apparatus due to the above-described deviation. The optimum writing condition measured when fabricating a certain writable medium may be, for example, a reference light power value of 5 mW. However, in view of the recording/reproducing apparatus, the optimum writing condition with respect to the above-described medium may be a light power value of 11 mW. In this case, even when performing the optimum writing optical detection process by varying the light power value based on the reference light power value of 5 mW, since the steps (for example, 15 steps of increments 0.3 mW) for varying the light power value is limited, in view of the recording/reproducing apparatus, it is impossible to reach 11 mW which is the optimum writing condition of the writable optical storage medium.

Therefore, when fabricating the writable optical storage medium, even when the optimum optical writing power detection process is performed based on the reference light power set during a writable optical storage medium manufacturer, the recording/reproducing apparatus does not detect the optimum writing light power.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide an optimum optical writing condition detection and storing method and an optical writing apparatus using the same which are capable of judging an optimum optical writing condition of an writable optical storage medium by the manufacturer thereof, storing the optimum condition into a certain storing unit based on the manufacturer of the writable optical storage medium, judging the manufacturer of the writable optical storage medium when writing an input signal into a certain writable optical storage medium, reading an optimum writing condition corresponding to the manufacturer from the storing unit, detecting an optimum writing light power based on the read-out optimum writing condition and writing an input signal based on the optimum writing light power.

It is another object of the present invention to provide an optimum writing condition detection and storing method and a writing method using the same which are capable of judging an optimum writing condition by the manufacturing company of an writable optical storage medium manufacturer, storing an optimum condition into a certain storing unit based on the manufacturer of the writable optical storage medium, judging the manufacturer of the writable optical storage medium when writing an input signal into a certain writable optical storage medium, reading an optimum writing condition corresponding to the manufacturer from the storing unit and detecting an optimum writing light power based on the read-out optimum writing condition.

To achieve the above objects, there is provided an optimum writing condition detection and storing method for a writable optical storage medium according to the present invention which includes a first step for changing an energy content of a writing beam at a certain writable optical storage medium which is different depending on the manufacturer of the same and writing a certain data into a certain region of the writable optical storage medium, a second step for reproducing the written data and detecting an optimum light energy content by the manufacturer based on the characteristic of the reproducing signal, and a third step for storing the optimum writing optical energy content based on a certain data of each manufacturer as the optimum writing optical energy content is detected in the second step.

To achieve the above objects, there is provided a writing light power adjusting apparatus for an writable optical storage medium according to the present invention which includes a storing unit for storing an optimum writing optical energy content based on the manufacturer of the writable optical storage medium with respect to a certain writable optical storage medium, a judging unit for judging the manufacturer of the writing medium, a writing unit for writing an input signal into the writable optical storage medium, and a writing unit for reading the optical writing optical energy content corresponding to the judged manufacturer from the optimum writing optical energy content and writing an input signal using the writing unit based on the optimum writing optical energy content.

Additional advantages, objects and features of the invention will become more apparent from the description which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

FIG. **1** is a schematic block diagram illustrating the construction of a conventional writable optical storage medium recording/reproducing apparatus;

FIG. **2** is a view illustrating a data format of a light power value written in a writable optical storage medium in the conventional art;

FIG. **3** is a graph illustrating a process for changing a light power based on a reference writing light power value when writing a test digital data to detect an optimum writing light power;

FIG. **4**A is a view illustrating a writing signal test region formed on a disk for an optimum writing light power detection;

FIG. **4**B is a view illustrating a PCA region;

FIG. **5** is a schematic block diagram illustrating the construction of an writable optical storage medium recording/reproducing apparatus according to the present invention;

FIG. **6** is a flow chart illustrating an optimum writing condition detecting and storing method for an writable optical storage medium according to the present invention;

FIG. **7** is a flow chart illustrating a writing light power adjusting method for an writable optical storage medium based on the optimum writing condition according to the present invention; and

FIGS. **8**A and **8**B are views respectively illustrating a lead-in and a lead-out start time data written on a writable optical storage medium.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An optimum writing condition detecting and storing method for a writable optical storage medium in accordance with the manufacturer thereof and an optimum writing light power detection adjusting apparatus using the optimum writing condition according to a preferred embodiment of the present invention will be explained.

FIG. **5** illustrates a writable optical storage medium recording/reproducing apparatus according to the present invention which has the same construction as the conventional recording/reproducing apparatus of FIG. **1** except for a microcomputer **600** connected with a memory **601** storing a plurality of manufacturer company information of the writable optical storage media and the optimum writing condition in corresponding with the manufacturer of each writable optical storage medium.

The writable optical storage medium recording/reproducing apparatus according to the preferred embodiment of the present invention reads certain information of the writable optical storage medium from a certain region of a certain writable medium, judges a manufacturer of the writable medium, determines an optimum writing condition corresponding to the thusly judged manufacturer from an memory **601** and searches an optimum writing light power based on the thusly judged optimum writing condition.

The operation of the writable optical storage medium recording/reproducing apparatus according to the present invention will be explained with reference to the accompanying drawings.

FIG. **6** is a flow chart which illustrates the steps of an optimum writing condition detection and stores the optimum writing condition to a certain memory **601**. When a writable optical storage medium **10** is inserted into a optical storage medium recording/reproducing apparatus in Step S**01**, the microcomputer **600** judges the type of writable optical storage medium (for example, CD-R or CD-RW) from a focusing error signal FE detected when the pick-up unit **11** accesses the writable optical storage medium **10** by controlling the servo unit **110** and the drive unit **90** in Step S**02**.

Next, a certain information data which is different depending on the manufacturer of the writable optical storage medium **10** is read from the writable optical storage medium **10** in Step S**03**. The information data which is different depending on the manufacturer is judged by reading the pre-recorded lead-in time from the writable optical storage medium **10** in the case of a CD-R and by reading the pre-recorded lead-out time in the case of a CD-RW. Here, the information data is stored in a time data format of Minutes, Seconds and Frames in the sub-Q information field of the lead-in region of or lead-out region in the writable optical storage medium **10**, in the case that the writable optical storage medium **10** is a recordable medium (for example, a CD-RW, a CD-R, etc.) as shown in FIGS. **8**A and **8**B.

When the pick-up unit **11** reads the written time data and outputs a high frequency signal to the digital reproducing signal processing unit **70***b*, the digital reproducing signal processing unit **70***b* converts the high frequency signal into a digital data and performs an Eight to Fourteen Modulation (EFM) and ECC decoding operation and transmits a result of the EFM modulation and ECC decoding operation to the microcomputer **600**. The microcomputer **600** detects an identification code (for example, a code indicating the medium manufacturer, etc.) from the time data obtained during the decoding process in Step S**04** and temporarily stores the identification character in Step S**05**.

Next, the microcomputer **600** controls the LD driving unit **81** so that the light energy content (writing power level and write strategy) gradually is changed and the test digital data is written into a certain region of the writable optical storage medium. Thereafter, the microcomputer **600** detects an optimum light energy content (or optimum writing condition) having a good reproducing characteristic and stores the detected optimum light energy content into a memory **601**.

The above-described operation is performed with respect to the writable optical storage medium of the different medium manufacturers, and the optimum light energy content (or the optimum writing condition) is detected in Step S**06**. As shown in the following Tables 1 and 2, the detected optimum light energy content (or optimum writing condition) is stored into a certain storing unit in accordance with the manufacturers of the writable medium in Step S**07**.

TABLE 1

In the case of a CD-R (1x speed)

Manufacturer	Lead-in start time	1W2W3	Optimum light energy content (power level [mW])
Kodak	97:27:45	10	6.0
Mitsui	97:27:55	00	5.6
Ricoh(A)	97:27:66	01	5.8
Anix	97:23:10	00	6.0
Ritex	97:31:00	10	6.6
Mitsubishi	97:34:20	10	6.6
Woong Jin	97:28:21	11	6.8
TDK	97:32:00	10	6.8
CMC	97:26:60	01	6.2
SMC	97:15:00	00	5.8
Maxwel	97:25:21	11	6.8
Ricoh(B)	97:27:00	01	6.6
BTC	97:22:18	10	6.8
Pioneer	97:27:25	11	7.0
SKC	97:26:23	00	5.8
Taiyo Yuden	97:24:01	01	6.0

TABLE 2

In the case of a CD-RW (2x speed)

Manufacturer	Lead-out start time	1W2W3	Optimum light energy content (power level [mW])
MCC	74:30:00	100	12.4
Ricoh	74:12:00	101	12.6
Ritex	74:45:00	010	12.2

The thusly stored information is used as an information with respect to the optimum light energy content (or optimum writing condition) of the writable optical storage medium when manufacturing the recording/reproducing apparatus for a writable optical storage medium and is stored into the storing unit of the recording/reproducing apparatus.

Here, table 1 illustrates the manufacturers of the writable optical storage medium (CD-R) based on 1×speed and the time data corresponding thereto, and Table 2 illustrates the manufacturers of the rewritable optical storage medium (CD-RW) based on 2×speed and the time data corresponding thereto. In the present invention, the data of Tables 1 and 2 include the optimum light energy contents, especially power level.

FIG. **7** illustrates an optimum light energy content adjusting method for a writable optical storage medium according to one embodiment of the present invention. The microcomputer **600** receives a FE signal from the pick-up unit **11** and judges whether a writable optical storage medium is loaded in the writable optical storage recording/reproducing apparatus in Step S**10**. If it is loaded, the microcomputer **600** receives a signal outputted R/F unit **100** and determines the type of the writable optical storage medium in Step S**11**.

Next, the microcomputer **600** controls the servo unit **110** and the drive unit **81**, and the pick-up unit **11** reads out the time data corresponding to a certain information of the writable optical storage medium written in a certain region of the writable optical storage medium, so that it is possible to recognize the time data by the manufacturer from the signals recovered by the digital reproducing signal processing unit **70***b*. The microcomputer **600** searches the time data by the manufacturer of the optical storage medium stored in the memory **601** in the formats as shown in Tables 1 or 2 generated based on the processes of FIG. **6** and judges the manufacturer of the writable optical storage medium in Step S**13**.

After the manufacturer of the inserted writable optical storage medium **10** is judged, the optimum light energy content (or optimum writing condition) is read out from the memory **601** in Step S**14**.

The microcomputer **600** performs an optimum writing light power detection process by varing the writing light power according to an increment of a energy content based on the optimum writing energy content (or optimum writing condition) as a reference start point in Step S**15** and detects an optimum writing light power of the writable optical storage medium.

After the optimum writing light power is obtained irrespective of a characteristic deviation of the writable optical storage medium in accordance with the manufacturer of the writable optical storage medium, the microcomputer **600** applies a control signal corresponding to the optimum writing light power to the LD driving unit **81** and applies a driving current corresponding thereto to the pick-up unit **11** via the LD driving unit **81** in Step S**16**.

The input signal converted by the A/D converter **20** is encoded into a MPEG format by the MPEG encoder **30** and is changed to a corresponding bit stream format by the digital signal processing unit **70***a* and the channel bit encoder **80**. Thereafter, the bit stream data is written into a user's data recording region of the writable optical storage medium **10** by the pick-up unit **11**.

As described above, in the optimum writing condition detection and storing method in accordance with the manufacturer of the writable optical storage medium and a writing light power detection adjusting apparatus using the same and a method thereof according to a preferred embodiment of the present invention, the manufacturer of the writable medium and an optimum writing condition of a writable medium corresponding to the manufacturer are detected and stored in a memory of the writable optical medium recording/reproducing apparatus. When writing an input signal into the writable optical storage medium, the manufacturer of the writable optical storage medium inserted in the writable optical storage medium recording/reproducing apparatus is judged by the microcomputer. The optimum writing condition is detected based on the manufacturer of the writable optical storage medium, and the optimum writing light power is obtained based on the optimum writing condition, and an input signal is recorded in the program region of the writable optical storage medium based on the optimum writing light power. Therefore, in the present invention, it is possible to write an input signal into an writable optical storage medium irrespective of the manufacturer of the writable optical storage medium by preventing a non-detection phenomenon of the optimum writing light due to a characteristic deviation of the writable optical storage medium according to the manufacturer of the writable optical storage medium, and it is possible to reproduce the recorded signals from the user's data recording region of the writable optical storage medium without an error.

Although the preferred embodiment of the present invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as recited in the accompanying claims.

What is claimed is:

1. A method of establishing optimum test writing parameters for test writing of a writable optical storage media, which optimum test writing parameters are specific to both an optical storage media recording/reproducing apparatus and to a writable optical storage medium manufactured by a respective one of a plurality of media manufacturers and which optimum test writing parameters are established independently of and without being constrained by default test-writing reference power parameters pre-recorded in the writable optical storage media during its manufacture, the method comprising:

detecting information pre-recorded in a writable optical storage medium during its manufacture which uniquely specifies the writable optical storage medium's respective manufacturer;

performing a test writing parameter optimization on the writable optical storage medium to determine optimized test writing parameters for the writable optical storage medium, by writing test digital data to the writable optical storage medium while changing a light energy content, the light energy content being the writing power level and write strategy employed by the

recording/reproducing apparatus when writing the test digital data to the writable optical storage medium;

reproducing the written test digital data from the writable optical storage medium and, in accordance with said reproduction, determining an optimum test writing light energy content representing optimum test writing parameters having a reproducing characteristic specific to both the writable optical storage medium and the recording/reproducing apparatus, the determined writable optical storage medium and recording/reproducing apparatus specific optimum test writing parameters being thereby established with specificity to the recording/reproducing apparatus employed and separately of default test-writing parameters pre-recorded in the writable optical storage media during its manufacture; and

storing the determined optimum test writing parameters specific to both the writable optical storage medium and the recording/reproducing apparatus in a memory of the recording/reproducing apparatus in association with the information specifying the respective manufacturer of the writable optical storage medium.

2. The method of claim **1**, further comprising:

determining optimum test writing parameters specific to the recording/reproducing apparatus for a plurality of writable optical storage media manufactured by different respective manufacturers of the plurality of manufacturers.

3. The method of claim **2**, further comprising:

storing the established manufacture-specific optimum test writing parameters corresponding to each respective manufacturer's writable optical storage medium in a memory of a recording/reproducing apparatus in association with the information detected from each writable optical storage medium uniquely specifying the respective manufacturer thereof.

4. The method of claim **1**, wherein the detected information is time information of a lead-in area or lead-out area recorded on the writable optical storage medium during manufacturing of the writable optical storage medium, and wherein the time information is indicated in units of Minutes, Seconds and Frames.

5. A method of establishing manufacturer-specific optimum test writing parameters for writing of a writable optical storage medium with specificity to a recording/reproducing apparatus, comprising:

detecting information contained in a writable optical storage medium which uniquely specifies the writable optical storage medium's respective manufacturer; and

setting pre-determined manufacturer-specific optimum test writing parameters corresponding to the detected information specifying the respective manufacturer of the writable optical storage medium, the manufacturer-specific optimum test writing parameters having been previously determined with specificity to the recording/reproducing apparatus through a test writing parameter optimization performed with such a recording/reproducing apparatus upon writable optical storage media manufactured by the respectively identified manufacturer and independently of and without being constrained to default test writing reference power parameters pre-recorded in the writable optical storage medium during its manufacture.

6. The method of claim **5**, further comprising:

performing a writing parameter optimization on the writable optical storage medium, to determine optimized writing parameters for writing to the writable optical storage medium, by test writing to the writable optical storage medium using the set optimum test writing parameters.

7. The method of claim **5**, further comprising:

determining optimum test writing parameters for writable optical storage media manufactured by a plurality of different manufacturers, for establishing manufacturer-specific optimum test writing parameters corresponding to each respective manufacturer's writable optical storage medium.

8. The method of claim **7**, further comprising:

associating the established manufacturer-specific optimum test writing parameters corresponding to each respective manufacturer's writable optical storage medium with an information contained in a writable optical storage medium uniquely specifying the respective manufacturer thereof.

9. The method of claim **5**, wherein the detected information is time information of a lead-in area or lead-out area recorded on the writable optical storage medium during manufacturing of the writable optical storage medium, and wherein the time information is indicated in units of Minutes, Seconds and Frames.

10. A method of establishing optimum writing parameters for writing of a writable optical storage medium specific to both the writable optical storage medium and a recording/reproducing apparatus, comprising:

detecting information recorded on a writable optical storage medium specifying the respective manufacturer of the writable optical storage medium;

setting previously established optimum test writing parameters corresponding to the detected information, the optimum test writing parameters having been previously determined with specificity to a recording/reproducing apparatus through a test writing parameter optimization procedure performed with such a recording/reproducing apparatus upon writable optical storage media manufactured by the respectively identified manufacturer and independently of and without being constrained by default test writing reference power parameters pre-recorded in the writable optical storage medium during its manufacture, for test writing of the writable optical storage medium; and

performing a write parameter optimization on the writable optical storage medium using the previously established optimum test writing parameters to determine optimum writing parameters for writing of the writable optical storage medium.

11. The method of claim **10**, further comprising:

determining optimum test writing parameters for writable optical storage media manufactured by a plurality of different respective manufacturers, for establishing the manufacturer-specific optimum test writing parameters corresponding to each manufacturer.

12. The method of claim **10**, wherein the detected information is time information of a lead-in area or lead-out area recorded on the writable optical storage medium during manufacturing of the writable optical storage medium, and wherein the time information is indicated in units of Minutes, Seconds and Frames.

13. An apparatus for establishing optimum writing parameters for writing of a writable optical storage medium, comprising:

an optical pickup capable of detecting information contained in a writable optical storage medium uniquely specifying the respective manufacturer of the writable optical storage medium;

a memory storing therein a plurality of pre-determined manufacture-specific optimum test writing parameters corresponding to writable optical storage media manufactured by a plurality of different respective manufacturers and also storing in association therewith information uniquely specifying the manufacturer of each writable optical storage medium corresponding to such optimum test writing parameters, the manufacturer-specific optimum test writing parameters having been previously determined with specificity to such an apparatus through a test writing parameter optimization performed with such an apparatus upon writable optical storage media manufactured by the respectively identified manufacturer and independently of and without being constrained by default test writing reference power parameters pre-recorded in the writable optical storage medium during its manufacture; and

a controller, operatively coupled with each of the optical pickup and the memory controlling the optical pickup to detect from the writable optical storage media the information contained therein uniquely specifying the manufacturer of the writable optical storage medium, and controlling the optical pickup for performing a writing parameter optimization on the writable optical storage media to determine optimum writing parameters for writing of the optical storage medium by test writing to the writable optical storage medium using the stored previously established manufacturer-specific optimum test writing parameters corresponding to the detected information.

14. The apparatus of claim **13**, wherein the detected information is time information of a lead-in area or lead-out area recorded on the writable optical storage medium during manufacturing of the writable optical storage medium, and wherein the time information is indicated in units of Minutes, Seconds and Frames.

15. An apparatus for establishing manufacturer-specific optimum writing parameters for writing of a writable optical storage medium, comprising:

storage means for storing pre-determined manufacturer-specific optimum test writing parameters respectively corresponding to writable optical storage medium manufactured by a plurality of different manufacturers, the pre-determined optimum test writing parameters for each respective writable optical storage medium being stored together with associated identification information uniquely identifying the corresponding manufacturer thereof, the manufacturer-specific optimum test writing parameters having been previously determined with specificity to such apparatus through a test writing parameter optimization procedure performed with such an apparatus upon writable optical storage media manufactured by the respectively identified manufacturer and independently of and not constrained by default test writing reference power parameters pre-recorded in the writable optical storage medium during its manufacture;

detection means for detecting the pre-recorded identification information contained in the writable optical storage medium which uniquely specifies the respective manufacturer thereof; and

controller means for performing a write parameter optimization on the writable optical storage medium by test writing to the writable optical storage medium using the stored pre-determined manufacturer-specific optimum test writing parameters corresponding to the detected information specifying the respective manufacturer of the writable optical storage medium.

16. The apparatus of claim **15**, wherein the identification information contained in the writable optical storage medium is time information of a lead-in area or lead-out area recorded on the writable optical storage medium during manufacturing of the writable optical storage medium, and wherein the time information is indicated in units of Minutes, Seconds and Frames.

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EXHIBIT B

US006782488B1

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Park et al.

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(54) **METHOD AND APPARATUS OF RECORDING DATA IN THE OPTICAL RECORDING MEDIUM**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,270,877 A * 12/1993 Fukushima et al. 360/48
5,283,790 A * 2/1994 Kawashita 711/112
5,442,614 A * 8/1995 Tamegai 235/456
5,508,989 A * 4/1996 Funahashi et al. 369/47.14
5,526,335 A * 6/1996 Tamegai 369/30.04
5,528,571 A * 6/1996 Funahashi et al. 369/53.17
5,739,519 A * 4/1998 Tsuchiya 235/454
5,740,349 A * 4/1998 Hasbun et al. 714/710
5,914,928 A * 6/1999 Takahashi 369/275.3
6,025,966 A * 2/2000 Nemazie et al. 360/53
6,038,209 A * 3/2000 Satoh 369/275.3
6,212,647 B1 * 4/2001 Sims et al. 711/112

FOREIGN PATENT DOCUMENTS

EP 0-837-472 A2 4/1998
EP 0-845-780 A1 6/1998
EP 0-952-573 A2 10/1999
JP 8-249659 A 9/1996

* cited by examiner

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(57) **ABSTRACT**

The present invention relates to an optical recording medium and optical recording medium record/playback apparatus and method, for managing defective areas in a rewritable optical recording medium. Particularly, the present invention adds a linear replacement control (LRC) bit to a secondary defective list (SDL) entry to discriminate a defective block information that is listed at the SDL entry according to a linear replacement algorithm from a defective block information that is listed at the SDL entry according to a skipping algorithm. This allows the optical recording medium record/playback apparatus to transmit correct information to a host. Furthermore, when a defective block requiring a new replacement block is found while recording or playing back data when the spare area is full, instead of carrying out the linear replacement, the LRC bit is set in the SDL entry along with the location information of the defective block to indicate that the corresponding SDL entry was made when the spare area was full, whereby data is not written in the defective block or data of the defective block is not read when rewriting or reproducing the data afterward. Consequently, the present invention can provide efficient management over the optical recording medium.

46 Claims, 10 Drawing Sheets

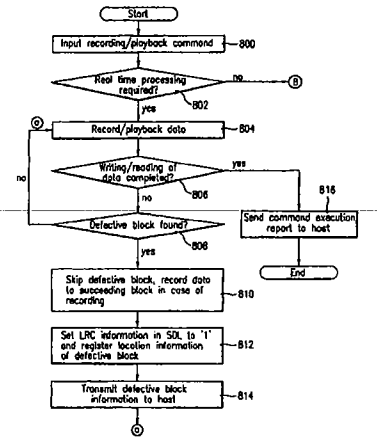

FIG. 1

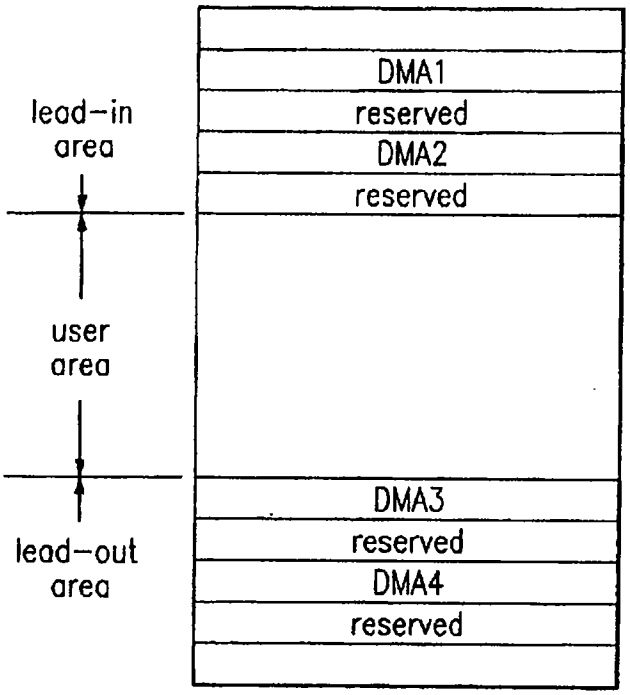

FIG. 2

b63	b62 ..... b56	b55 ..... b32	b31 ..... b24	b23 ..... b0
FRM	reserved	sector number of first sector of defective block	reserved	sector number of first sector of replacement block

FIG.3A

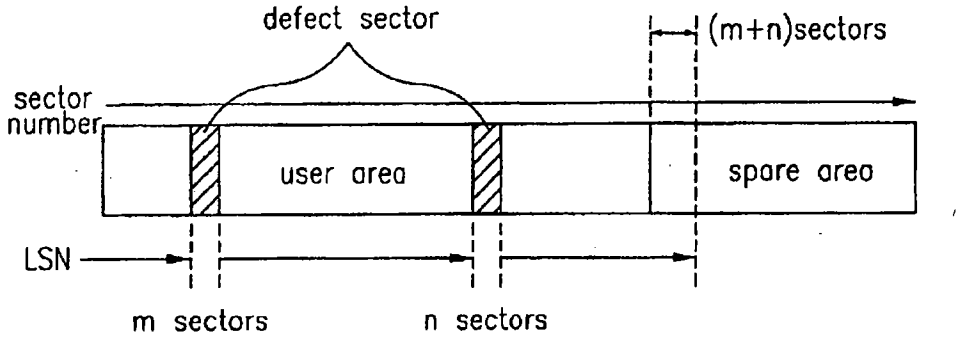
defect sector
(m+n)sectors
sector number
user area
spare area
LSN
m sectors
n sectors

FIG.3B

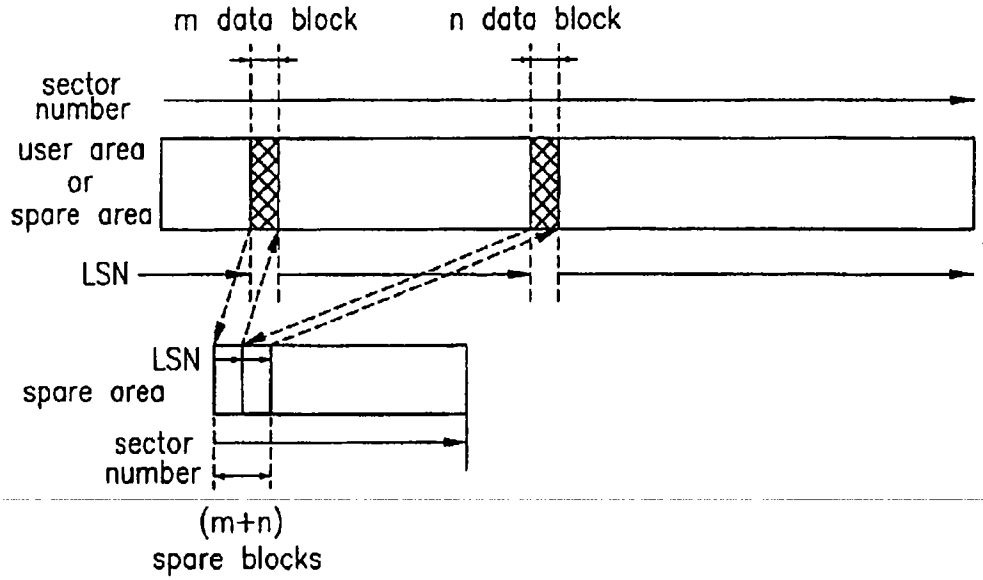
m data block
n data block
sector number
user area or spare area
LSN
LSN
spare area
sector number
(m+n) spare blocks

FIG.4A

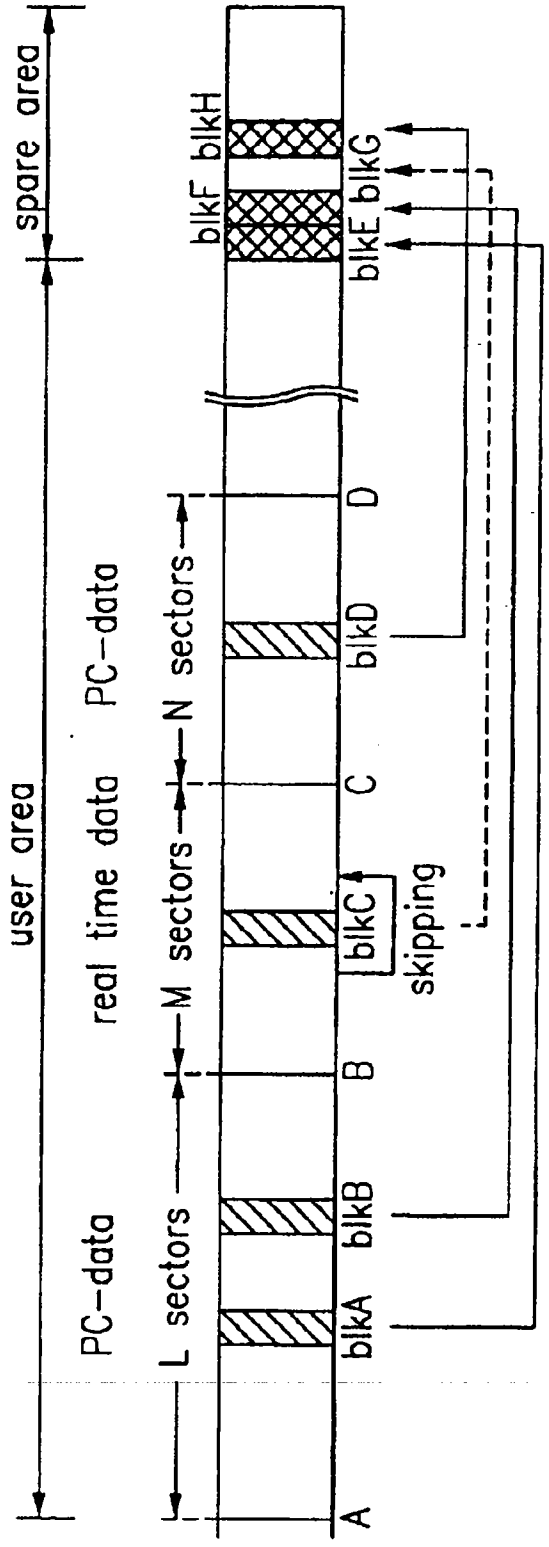
spare area
user area
PC-data
real time data
PC-data
L sectors
M sectors
N sectors
blkA
blkB
blkC
blkD
blkE
blkF
blkG
blkH
skipping
A
B
C
D

FIG.4B

FIG.4C

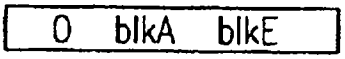

FIG.4D

FIG.5

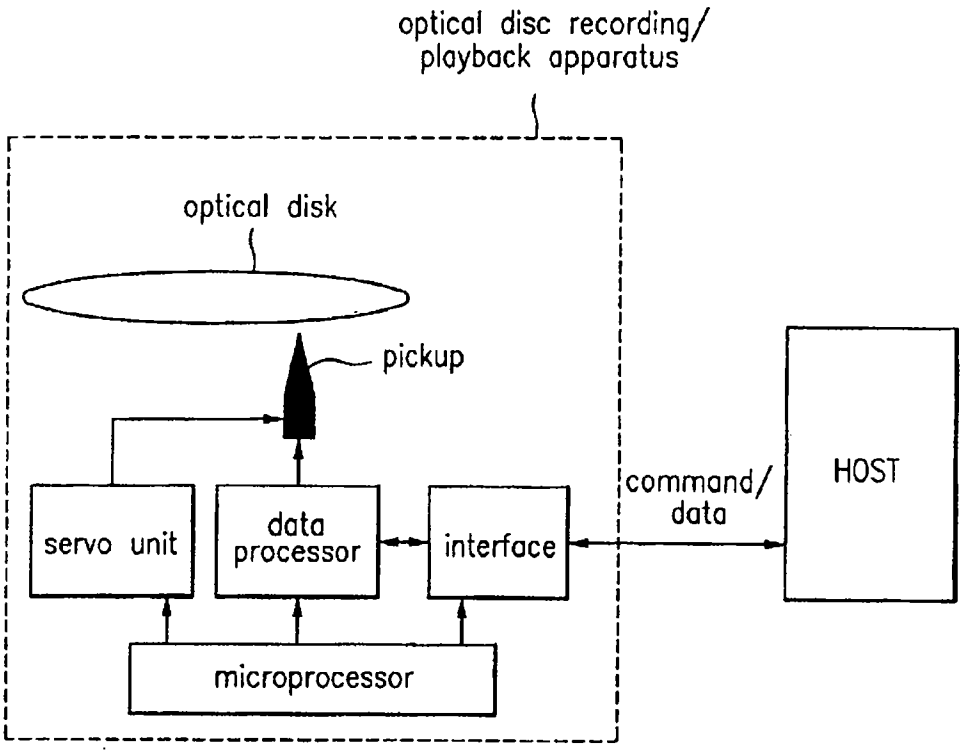
optical disc recording/
playback apparatus
optical disk
pickup
servo unit
data processor
interface
command/
data
HOST
microprocessor

FIG.6

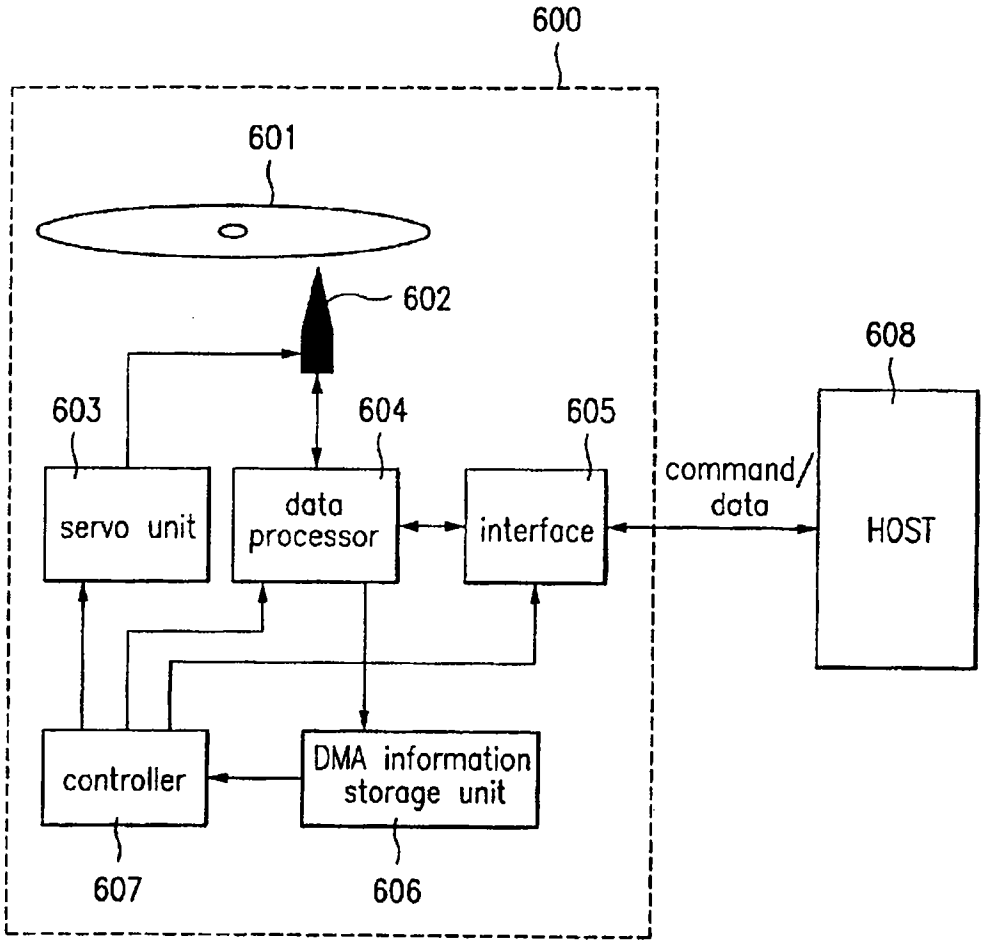
600
601
602
603
604
605
608
servo unit
data processor
interface
command/ data
HOST
controller
DMA information storage unit
607
606

FIG.7A

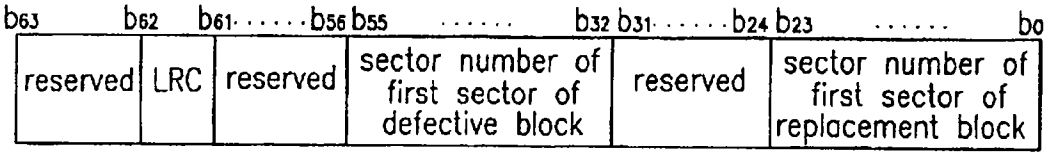

FIG.7B

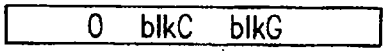

FIG.7C

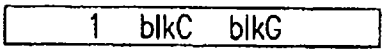

FIG.7D

FIG.8A

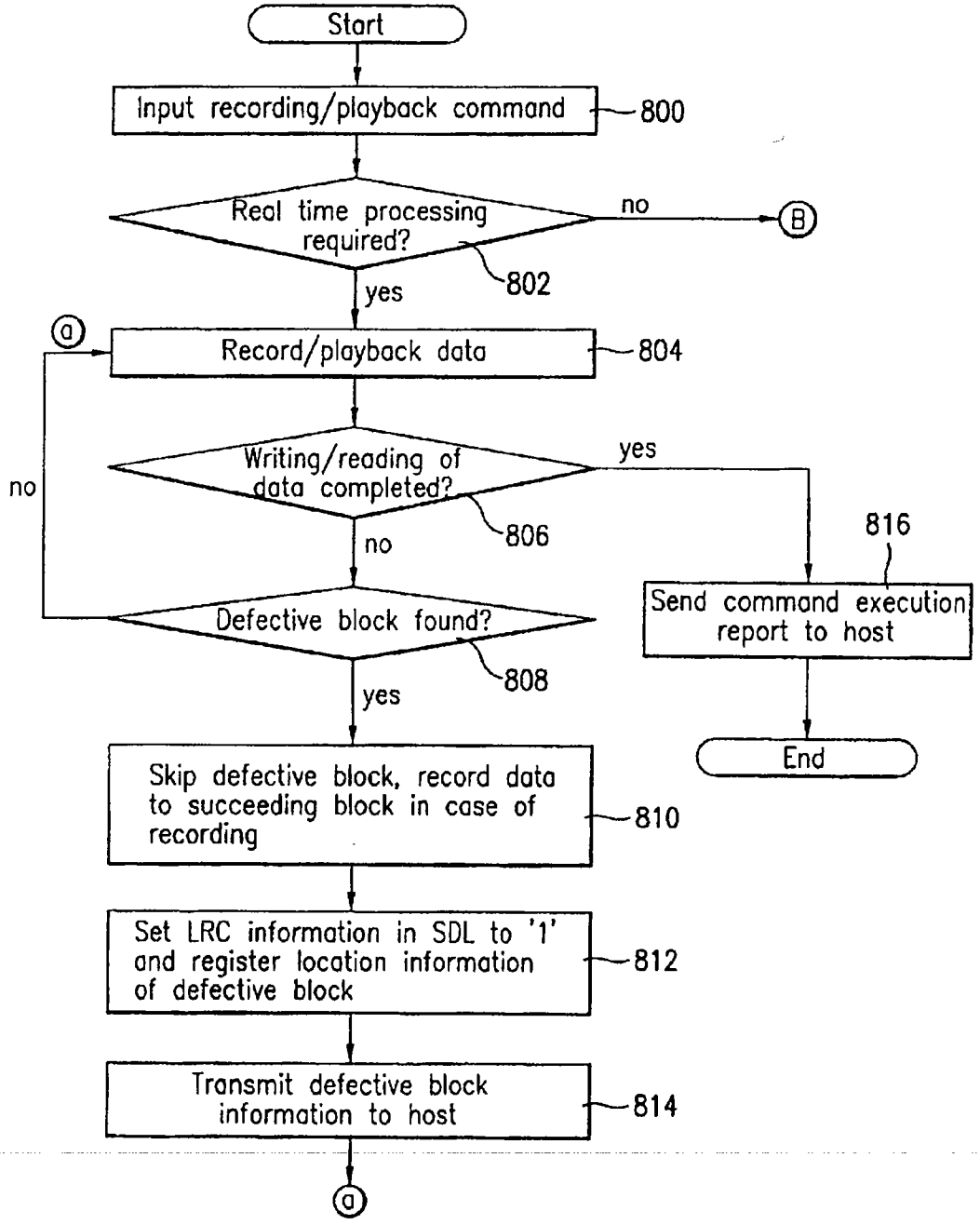
Start
Input recording/playback command
800
Real time processing required?
802
no
B
yes
a
Record/playback data
804
Writing/reading of data completed?
806
yes
no
816
Send command execution report to host
Defective block found?
808
yes
End
Skip defective block, record data to succeeding block in case of recording
810
Set LRC information in SDL to '1' and register location information of defective block
812
Transmit defective block information to host
814
a

FIG.8B

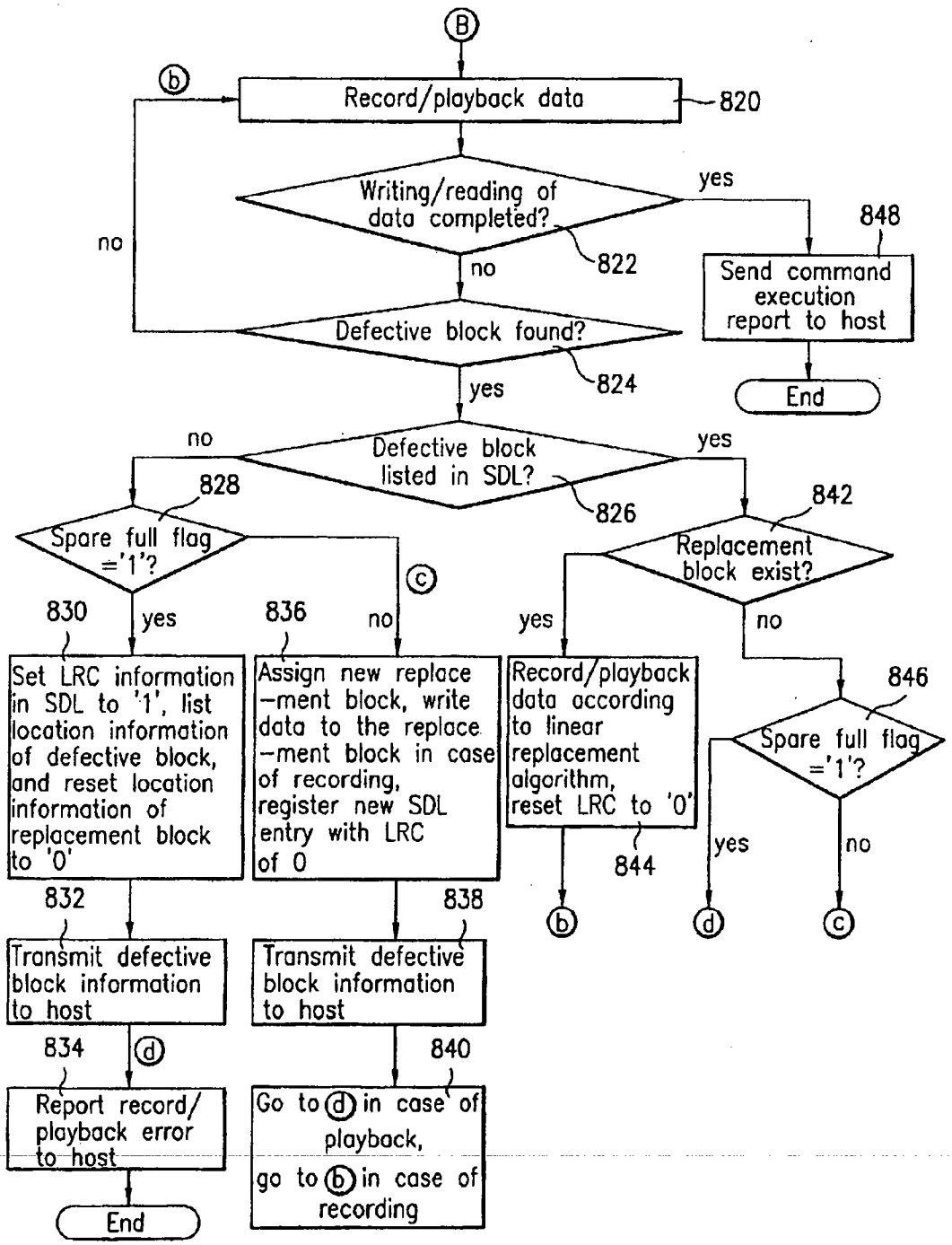
B
b
Record/playback data
820
Writing/reading of data completed?
yes
848
no
822
Send command execution report to host
Defective block found?
824
End
yes
no
Defective block listed in SDL?
yes
826
828
842
Spare full flag ='1'?
Replacement block exist?
c
830
yes
836
no
yes
no
Set LRC information in SDL to '1', list location information of defective block, and reset location information of replacement block to '0'
Assign new replace-ment block, write data to the replace-ment block in case of recording, register new SDL entry with LRC of 0
Record/playback data according to linear replacement algorithm, reset LRC to '0'
846
Spare full flag ='1'?
844
yes
no
b
d
c
832
838
Transmit defective block information to host
Transmit defective block information to host
834
d
840
Report record/ playback error to host
Go to d in case of playback, go to b in case of recording
End

FIG.9

METHOD AND APPARATUS OF RECORDING DATA IN THE OPTICAL RECORDING MEDIUM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical recording medium which allows rewriting, and more particularly to a method and apparatus of recording data in the optical recording medium, wherein defect areas can be managed.

2. Description of Related Art

An optical storage medium is generally divided into a read only memory (ROM), a write once read many (WORM) memory into which data can be written one time, and rewritable memories into which data can be written several times. Rewritable optical storage mediums, i.e. optical discs, include rewritable compact discs (CD-RW) and rewritable digital versatile discs (DVD-RW, DVD-RAM, DVD+RW).

The operations of writing and playing back data in a rewritable optical disc may be repeated. This repeated process alters the ratio of storage layers for recording data into the optical disc from the initial ratio. Thus, the optical discs lose its characteristics and generate an error during recording/playback. This degradation is indicated as a defective area at the time of formatting, recording on or playing back from an optical storage medium. Also, defective areas of a rewritable optical disc may be caused by a scratch on its surface, particles of dirt and dust, or errors during manufacture. Therefore, in order to prevent writing into or reading out of the defective area, management of such defective areas is necessary.

FIG. 1 shows a defect management area (DMA) in a lead-in area and a lead-out area of the optical disc to manage a defect area. Particularly, the data area is divided into a plurality of zones for the defect area management, where each zone is further divided into a user area and a spare area. The user area is where data actually written and the spare area is used when a defect occurs in the user area.

There are four DMAs in one disc, e.g. DVD-RAM, two of which exist in the lead-in area and two exist in the lead-out area. Because managing defective areas is important, the same contents are repeatedly recorded in all four DMAs to protect the data. Each DMA comprises two blocks of 32 sectors, where one block comprises 16 sectors. The first block of the DMA, called a DDS/PDL block, includes a disc definition structure (DDS) and a primary defect list (PDL). The second block of the DMA, called an SDL block, includes a secondary defect list (SDL). The PDL corresponds to a primary defect data storage and the SDL corresponds to a secondary defect data storage.

The PDL generally stores entries of defective sectors caused during the manufacture of the disc or identified when formatting a disc, namely initializing and re-initializing a disc. Each entry is composed of an entry type and a sector number corresponding to a defective sector. The SDL lists defective areas in block units, thereby storing entries of defective blocks occurring after formatting or defective blocks which could not be stored in the PDL during the formatting. As shown in FIG. 2, each SDL entry has an area for storing a sector number of the first sector of a block having defective sectors, an area for storing a sector number of the first sector of a block replacing the defective block, and reserved areas.

Also, each SDL entry is assigned a value of 1 bit for forced reassignment marking (FRM). A FRM bit value of 0 indicates that a replacement block is assigned and that the assigned block does not have a defect. A FRM bit value of 1 indicates that a replacement block has not been assigned or that the assigned replacement block has a defect. Thus, to record data in a defective block listed as a SDL entry, a new replacement block must be found to record the data. Accordingly, defective areas, i.e. defective sectors or defective blocks, within the data area are replaced with normal or non-defective sectors or blocks by a slipping replacement algorithm and a linear replacement algorithm.

The slipping replacement is utilized when a defective area or sector is recorded in the PDL. As shown in FIG. 3A, if defective sectors m and n, corresponding to sectors in the user area, are recorded in the PDL, such defective sectors are skipped to the next available sector. By replacing the defective sectors by subsequent sectors, data is written to a normal sector. As a result, the user area into which data is written slips and occupies the spare area in the amount equivalent to the skipped defective sectors.

The linear replacement is utilized when a defective block is recorded in the SDL or when a defective block is found during playback. As shown in FIG. 3B, if defective blocks m and n, corresponding to blocks in either the user or spare area, are recorded on the SDL, such defective blocks are replaced by normal blocks in the spare area and the data to be recorded in the defective block are recorded in an assigned spare area. To achieve the replacement, a physical sector number (PSN) assigned to a defective block remains, while a logical sector number (LSN) is moved to the replacement block along with the data to be recorded. Linear replacement is effective for non real-time processing of data. For convenience, a data which does not require real time processing is hereinafter called a personal computer (PC)-data.

If a replacement block listed in the SDL is found to be defective, a direct pointer method is applied to the SDL listing. According to the direct pointer method, the defective replacement block is replaced with a new replacement block and the SDL entry of the defective replacement block is modified into a sector number of the first sector of the new replacement block.

FIG. 4A shows a procedure to manage a defective block found while writing or reading data into or from the user area. FIGS. 4B~4D show embodiments of SDL entries generated according to the linear replacement algorithm. Each SDL entry has, in order, a FRM, a sector number of the first sector of the defective block, and a sector number of the first sector of the replacement block.

For example, if the SDL entry is (1, blkA, 0) as shown in FIG. 4B, a defective block has been newly found during the reproduction and is listed in the SDL. This entry indicates that a defect occurs in block blkA and that there is no replacement block. The SDL entry is used to prevent data from being written into the defective block in the next recording. Thus, during the next recording, the defective block blkA is assigned a replacement block according to the linear replacement.

An SDL entry of (0, blkA, blkE), shown in FIG. 4C, indicates that the assigned replacement block blkE has no defect and data to be written into the defective block bikA in the user area is written into the replacement block blkE in the spare area. An SDL entry of (1, blkA, blkE) shown in FIG. 4D, indicates that a defect occurs in the replacement block blkE of the spare area which replaced the defective

block blkA of the user area. In such case, a new replacement block is assigned according to the direct pointer method.

FIG. 5 is a partial diagram of an optical disc recording/playback (R/P) device relating to the recording operation. The optical disc (R/P) device includes an optical pickup to write data into and playback data from the optical disc; a servo unit controlling the optical pickup to maintain a certain distance between an object lens of the optical pickup and the optical disc, and to maintain a constant track; a data processor either processing and transferring the input data to the optical pickup, or receiving and processing the data reproduced through the optical pickup; an interface transmitting and receiving data to and from an external host; and a micro processor controlling the components. The interface of the optical disc R/P apparatus is coupled to a host such as a PC, and communicates commands and data with the host.

If there is data to be recorded in an optical disc R/P apparatus, the host sends a recording command to the optical disc R/P apparatus. The recording command comprises a logical block address (LBA) designating a recording location and a transfer length indicating a size of the data. Subsequently, the host sends the data to be recorded to the optical disc R/P apparatus. Once the data to be written onto an optical disc is received, the optical disc R/P apparatus writes the data starting from the designated LBA. At this time, the optical disc R/P apparatus does not write the data into areas having by referring to the PDL and SDL which indicate defects of the optical disc.

Referring back to FIG. 4A, the optical disc R/P apparatus skips physical sectors listed in the PDL and replaces the physical blocks listed in the SDL, within the area between A and B, with assigned replacement blocks in the spare area during the recording. If a defective block not listed in the SDL or a block prone to an error is found during the recording or playback, the optical disc R/P apparatus considers such blocks as defective blocks. As a result, optical disc R/P apparatus searches for a replacement block in the spare area to rewrite the data corresponding to the defective block and lists the first sector's number of the defective block and the first sector's number of the replacement block at the SDL entry.

To perform the linear replacement, namely to write the data into the assigned replacement block in the spare area when finding a defective block (listed or not listed in the SDL), the optical disc R/P apparatus must move the optical pickup from the user area to the spare area and then back to the user area. Because moving the optical pickup may take time, a linear replacement interferes a real time recording.

Thus, defect area management methods for real time recording, such as audio visual apparatus, have been extensively discussed. One method is to use a skipping algorithm where a defective block is skipped and data is written into the next normal block, similarly to the slipping replacement algorithm. If this algorithm is employed, the optical pickup does not need to be moved to the spare area whenever a defective block is found, such that the time needed for moving the optical pickup can be reduced and the interference with the real time recording can be removed.

For example, if the PC-data which does not require real time processing, as shown in FIG. 4A, is received when the SDL is used, the linear replacement algorithm is executed upon finding defective blocks blkA and blkB. If the received data requires real time, as shown in the area between B and C of FIG. 4A, the skipping algorithm is used upon finding defective block blkC. Namely, the linear replacement is not performed. For linear replacement, the PSN of the defective

block is maintained as is and the LSN of the defective block is moved to the replacement block. For the skipping algorithm, both the LSN and PSN of the defective block blkC are maintained as they are.

Accordingly, when the host reads the data recorded according to the skipping algorithm, the microprocessor transmits all data including data of defective blocks through the interface. However, the host cannot identify the data of the skipped defective block since it does not have information regarding the skipped defective blocks, resulting in an incorrect playback of the data. Therefore, the microprocessor of the optical disc R/P apparatus must instruct the optical pickup not to read the data of defective blocks among the data playback from the optical disc and transmitted to the host. Here, the information regarding the defective blocks, as shown in FIGS. 4B–4D, remains in the SDL and the microcomputer may transmit the information to the host, on request.

The SDL is information on defective blocks with respect to the linear replacement algorithm. However, the microprocessor cannot discriminate information recorded with respect to linear replacement from information recorded with respect to skipping algorithm not performing the linear replacement. Consequently, if skipping algorithm has been used, the microprocessor may transmit incorrect information to the host. Likewise, the host cannot identify the data of skipped defective blocks, resulting in an erroneous playback of data.

Moreover, because of the size of the spare may not be sufficient, the spare area may become full while the DMA has redundant areas for listing defective blocks at the PDL or SDL entries. If the spare area is full, a spare full flag in the DMA is set. The spare area may become full prior to the DMA when the initial allocation of spare area is insufficient or when the available spare area is quickly reduced due to defects, particularly burst defects occurring in the spare area. Because it is desirable to increase the recording capacity of the optical disc, a method of further reducing the size of the spare area has been considered. In such case, however, there is a higher possibility that the spare area will become full prior to the DMA.

Consequently, if the optical disc R/P apparatus finds a defective block that is not listed in the SDL or is listed in the SDL but requires a new replacement block as shown in FIGS. 4B–4D while recording or playing back data, it checks the spare full flag of the DMA. If the spare full flag is in a reset state which indicates that available spare areas remain, the apparatus records the data of the defective block in a replacement block in the spare area and lists a new SDL entry or modifies the existing SDL entry. On the other hand, if the spare full flag is in a set state, which indicates that the spare area is full, a linear replacement cannot be executed even if the DMA has redundant area. If the linear replacement cannot be executed when necessary, the management of defective area cannot be maintained. As a result, the disc cannot be used.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to solve at least the problems and disadvantages of the related art.

An object of the present invention is to provide an optical disc and a defect management method for managing defect of the optical disc according to whether a replacement block has been assigned.

Another object of the present invention is to provide a data recording method and apparatus which discriminately

store and manage information on defective blocks within the optical disc according whether a replacement block has been assigned.

Still another object of the present invention is to provide an optical disc, a defect management method for managing defect of such optical disc, and data recording method and apparatus for storing information on defective blocks according to whether linear replacement is performed.

A further object of the present invention is to provide an optical disc, a defect management method for managing defect of such optical disc, and data recording method and apparatus for storing information on defective blocks without application of linear replacement if there is no available replacement area.

A still further object of the present invention is to provide an optical disc, a defect management method for managing defect of such optical disc, and data recording method and apparatus for discriminately storing information on defective blocks skipped for real time processing or skipped due to a full spare area, and information on defective blocks related to linear replacement algorithm.

A still further object of the present invention is to provide an optical disc, a defect management method for managing defect of such optical disc, and data recording method and apparatus for discriminately storing information on defective blocks listed at SDL entries by giving identification information to the SDL entries according to whether linear replacement is performed.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objects and advantages of the invention may be realized and attained as particularly pointed out in the appended claims.

To achieve the objects and in accordance with the purposes of the invention, as embodied and broadly described herein, an optical disc has a DMA for managing defects and comprises an area for recording identification information in the DMA. The identification information allows discrimination between when a replacement block has been assigned according to a linear replacement algorithm and when a replacement block is not assigned. The area for recording the identification information is assigned in a reserved area of a SDL entry in the DMA. The identification information indicates that a defective block was listed in the SDL either while data was recorded according to a skipping algorithm or when a spare area was full.

A defect management method of an optical disc according to an embodiment of the present invention comprises determining whether to assign a replacement block if a defective block is found during recording in the optical disc; and storing information on the defective block and storing identification information to discriminate a defective block with an assigned replacement block from a block without an assigned replacement block, based upon the results of the determination.

Information regarding a replacement block is not stored during real time recording. Also, information regarding a replacement block is not assigned when there is no available replacement area. The identification information is stored at a secondary defect list in a defect management area together with the defective block information. Moreover, the forced reassignment marking information is reset to 0. Furthermore, the defective block information discriminated based upon the identification information is notified to a host that transmits a recording command.

In another embodiment, a defect management method of an optical disc according to the present invention comprises detecting existence/non-existence of an available replacement area if a defective block is found while recording the data in the optical disc; and storing information on the defective block and identification information indicating that a replacement block is assigned if available replacement area exists or a replacement block is not assigned if available replacement area does not exist. Available replacement block is determined not to exist if the data is recorded by skipping the defective block. Also, available replacement block is determined not to exist if the spare area is full.

In still another embodiment, a data recording method of an optical disc comprises receiving data and information of areas where data will be written in the optical disc; reading defective area information of the optical disc; detecting whether the defective area information covers a defective block that is found during the recording; detecting whether a replacement block is assigned to the defective block based upon the identification information contained in the defective area information if the found defective block is covered by the defective area information, and if a replacement block is assigned, writing the data in the assigned replacement block and, if not, finding a new available replacement block to write the data therein; and determining whether the defective block will be replaced with a replacement block if the defective block is not covered by the defective area information, and storing information on the defective block and the identification information to discriminate if a replacement block is assigned to the defective block in the defect management area of the disc based upon a result of the determination. The identification information is represented with at least one bit of a reserved area at a secondary defect list within the defect management area.

Moreover, a real time data recording method of an optical disc according to the present invention comprises receiving data and information regarding the area where the data will be written in the optical disc; skipping a defective block and writing the data in a following normal block if the defective block is found during the real time recording; and storing information regarding the skipped defective block discriminately from information on a defective block replaced with a replacement block.

The identification information is set to indicate that the defective block is not replaced with a replacement block. If the defective block is found while recording the data by skipping defective blocks and if information regarding a replacement block for the defective block is listed at a secondary defect list entry, the replacement block information is maintained as is when the defective block information is stored.

Furthermore, an optical disc recording apparatus comprises a controller detecting a defective block and determining whether a replacement block is assigned to the defective block while recording the data; an optical pickup recording and playing back data in/from the optical disc according to control of the controller; and a storage unit storing information regarding the defective block and identification information to discriminate whether a replacement block is assigned to a defective block.

The storage unit does not store the replacement block during real time recording and represents this fact using the identification information. The storage unit also does not store the replacement block if there is no available replacement area and represents this fact using the identification information.

These and other objects of the present application will become more readily apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The invention will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

FIG. **1** shows a data area of a conventional optical disc;

FIG. **2** illustrates a structure of a conventional SDL entry;

FIG. **3**A illustrates a conventional slipping replacement algorithm;

FIG. **3**B illustrates a conventional linear replacement algorithm;

FIG. **4**A illustrates a state of recording data according to the linear replacement algorithm or skipping algorithm when using SDL in the conventional optical disc;

FIGS. **4**B to **4**D illustrate embodiments of SDL entries listing information regarding defective blocks occurring when recording or playing back data according to the linear replacement algorithm;

FIG. **5** is a block diagram of a conventional optical disc recording/playback apparatus;

FIG. **6** is a block diagram of an optical disc recording/playback apparatus according to an embodiment of the present invention;

FIG. **7**A illustrates assigning identification information to an SDL entry according to an optical disc defect managing method of the present invention;

FIGS. **7**B to **7**D illustrate SDL entries discriminately listed while recording or playing back data according to the skipping algorithm and linear replacement algorithm using the identification information;

FIGS. **8**A and **8**B are flow charts showing how defective area is managed using the identification information of FIG. **7** according to an embodiment of the present invention; and

FIG. **9** illustrates an SDL entry listed while recording or playing back data according to the skipping algorithm after changing a definition of FRM in the optical disc defect managing method according to an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The present invention distinguishably lists information regarding defective blocks in the SDL according to whether linear replacement has been executed upon finding defective blocks while recording or playing back data in or from an optical disc. In one embodiment, the present invention distinguishably lists such information by assigning an identification information. In another embodiment, such information is distinguishably listed by changing a part of the FRM definition.

In the first embodiment of the present invention, information indicating whether or not a corresponding defective block is listed while data is recorded according to the linear replacement algorithm is written in a reserved area in the SDL entry.

FIG. **6** shows an optical disc recording/playback apparatus according to an embodiment of the present invention comprising an optical pickup **602** recording and playing back data to and from an optical disc **601**; a servo unit **603** controlling the optical pickup **602** to maintain a certain distance from an object lens of the optical pickup **602** to the optical disc **601**, and to maintain a specified track; a data processor **604** processing the input data and transmitting the processed data to the optical pickup **602**; a DMA information storage unit **606** reading and storing DMA information written in a DMA area of the optical disc via the data processor **604**; an interface **605** transmitting and receiving data to and from an external host **608**; and a controller **607** detecting whether a defective block exists during recording/playback of data and determining whether a linear replacement has been executed to the defective block. The interface **605** of the optical disc R/P apparatus is coupled to the host **608**, such as a PC, and communicates commands and data with the host **608**.

When a rewritable optical disc, for example a DVD-RAM, is inserted into the apparatus of the present invention, the SDL and PDL entries listed in the DMA area of the optical disc **601** are stored in the DMA information storage unit **606** through the data processor **604** under the control of the controller **607**. At this time, the identification information indicating whether linear replacement has been performed with respect to a corresponding defective block is added into the DMA information stored in the DMA information storage unit **606**.

For example, at least one bit of the reserved area in the existing SDL entry is assigned as the identification information (ID Info) bit. The ID Info bit is set to either a value of 1 or 0 to distinguish whether the linear replacement has been executed to the information listed in the SDL. Namely, the linear replacement algorithm is not performed when skipping algorithm is performed or when the spare area is full. In the present invention, the ID Info bit is called a linear replacement control (LRC) bit and shown in, e.g., FIG. **7**A.

Referring to FIG. **7**A, each SDL entry comprises an LRC area, an area for storing a sector number of the first sector of a block having defective sectors, and an area for storing a sector number of the first sector of a replacement block replacing the defective block. Because the LRC bit has a different meaning from the FRM bit, the FRM may also be included in the SDL. However, in this embodiment of the present invention. the FRM bit is not used.

As shown in FIG. **7**B, a LRC bit value of 0 in the SDL entry means that the SDL entry was made while recording the data according to the linear replacement algorithm. As shown in FIG. **7**C or **7**D, a LRC bit value of 1 means that the SDL entry was made while recording the data according to the skipping algorithm rather than the linear replacement or while the spare area is full. When a defective block is found during recording of data according to the linear replacement algorithm, the data corresponding to the defective block is recorded in a replacement block and the LRC bit is reset to 0, provided that the spare area is not full. Otherwise, if the spare area is full, the linear replacement is not performed and the LRC bit is set to 1. Also, when a defective block is found while recording the data according to the skipping algorithm, the defective block is skipped and the LRC bit of an SDL entry corresponding to the defective block is set to 1.

Once a predetermined time has passed, for example, during the recording of data or after completing the recording, the controller **607** transmits information regarding the defective blocks to the host. At such time, the controller **607** can detect whether or not the corresponding SDL entry was made while recording the data according to the linear replacement algorithm based upon the LRC bit, thereby being able to transmit the correct information to the host. Accordingly, the host can appropriately command not to record/playback data in/from defective blocks listed in the SDL.

The host may issue a write/read command in view of the defective blocks listed in the SDL. Namely, the host would command not to record or playback data in or from defective blocks listed in the SDL. The optical disc R/P apparatus receives both the data and information of areas where data will be written in the optical disc, and reads the information regarding defective areas of the optical disc. The optical disc R/P apparatus detects whether the defective area information covers a defective block that is found during the recording; and detects whether a replacement block is assigned to the defective block based upon the identification information contained in the defective area information if the found defective block is covered by the defective area information. If a replacment block is assigned, writing the data in the assigned replacement block is performed and, if not, finding a new available replacement. block to write the data therein is performed. The optical disc R/P apparatus further determines whether the defective block will be replaced with a replacement block if the defective block is not covered by the defective area information, and stores information on the defective block and the identification information to discriminate if a replacement block is assigned to the defective block in the defect management area of the disc based upon a result of the determination. The identification information is represented with at least one bit of a reserved area at a secondary defect list within the defect management area.

Thus, the optical disc R/P apparatus bypasses the defective blocks listed in the SDL while writing/reading the data. In such case, the LRC bit of SDL entry is set to 1 upon encountering a new defective block and location information of the defective block is entered. Since information regarding the replacement block is not necessary, the existing value is kept as is or a value of 0 is entered

Alternatively, if the host issues a write/read command regardless of the defective block information in the SDL, the controller **607** of the optical disc R/P apparatus identifies the defective blocks listed in the SDL based upon the DMA information stored in the DMA information storage unit **606** during the data record/playback. If the read command is issued, whether a replacement block should be found can be determined based upon the LRC bit of the SDL entry where the defective block is listed. If the write command is issued, the LRC bit of an existing entry may change depending upon whether or not the linear replacement algorithm is performed. Here, a newly found defective block is processed in the same way as described above. For example, if a defective block listed in the SDL is found while recording data according to the skipping algorithm, the defective block is skipped and the LRC bit of the SDL entry corresponding to the defective block is set to 1.

At this time, if the information regarding a replacement block is written in the area for storing the sector number of the first sector of the replacement block in the SDL entry, the information is maintained as is. For example, a SDL entry of (0, blkC, blkG) as shown in FIG. **7B**, means that data was recorded according to the linear replacement algorithm and a replacement block has been assigned. If such a SDL entry is met while recording data according to the skipping algorithm, the defective block blkC is skipped and the SDL entry is modified into (1, blkC, blkG) as shown in FIG. **7C**.

Thus, the SDL entry of (1, blkC, blkG) as show in FIG. **7C**, means that data was recorded according to the skipping algorithm, a defect occurred in block blkC, and the information regarding the replacement block blkG is maintained but not used during the record/playback. A SDL entry of (1, blkC, 0) as shown in FIG. **7D**, means that data was recorded according to the skipping algorithm and a new defective block blkC was found and entered. If such SDL entry is found while recording the data according to the skipping algorithm, the defective block blkC is skipped and the SDL entry is maintained as is.

If the information regarding the replacement block of the spare area, which was previously listed in the SDL entry according to the linear replacement algorithm, is maintained in the SDL entry as it was while recording the data according to the skipping algorithm, the replacement block information can be used in subsequent recordings. In other words, when writing data into such defective block listed in the SDL according to the linear replacement algorithm, if the replacement block information does not exist, a replacement block for the defective block must be newly assigned to the spare area. However, if the information regarding the replacement block is maintained, the location of the replacement block previously assigned can be used as the newly assigned replacement block.

For example, a block following the replacement block blkH, shown in FIG. **4A**, is assigned as the new replacement block. Since a replacement block that was previously assigned cannot be re-used, the available capacity of the optical disc is reduced, thereby decreasing the efficiency of the optical disc. Therefore, if the replacement block information is maintained even while recording data according to the skipping algorithm, as described above, the replacement block previously assigned can be re-used as is when writing data according to the linear algorithm in a subsequent recording, thereby increasing the efficiency of the optical disc.

Specifically, if the information regarding the replacement block blkG, where data of the defective block blkC was written during the linear replacement recording, is kept in the SDL entry during the real time recording, the data of the defective block blkC is written not into a new replacement block in the spare area but into the replacement block blkG, which has already been assigned, during the next linear replacement recording.

Meanwhile, if a defective block requiring a new replacement block is found during the record/playback using the linear replacement, but there is no replacement block for the defective block, namely the spare area is full (provided the DMA has redundancy), the LRC bit value of the SDL entry is set to 1. At this time, a replacement block does not exist. As a result, the replacement block information is not listed and the location information of the defective block is listed as shown in FIG. **7D**. If the spare full flag and the LRC bit is set to 1 during the playback or recording, data of the defective block cannot be read and data cannot be written in the defective block because the replacement block for the defective block does not exist and the linear replacement cannot be executed.

FIGS. **8A** and **8B** are flow charts showing the above operations of the optical disc R/P apparatus according to an embodiment of the present invention. If there is data to be

recorded, the host inputs a write command and if there is playback of data, the host inputs a read command, via the interface of the optical disc R/P apparatus (**800**). Once a write or read command is received from the host, the controller **607** of the optical disc R/P apparatus determines whether the input data requires a real time recording/playback (**802**).

When the data is determined to require real time recording, the apparatus starts to write the data on a location of the LBA designated by the host (**804**). A determination is made whether the writing of data is completed (**806**) and if a defective block is found when the writing of data is not completed (**808**), the defective block is skipped and the data is written in a next normal block (**810**). Information regarding the skipped defective block is entered in the SDL (**812**) and sent to the host (**814**). This information is entered in a way distinguishable from an information of a defective block found while performing the linear replacement algorithm. Thus, the controller **607** can distinguish SDL entry made while recording data according to the skipping algorithm from a SDL entry made while recording data according to the linear replacement algorithm. For this purpose, the LRC bit of the SDL is set to 1 and the location information of the defective block is entered in the SDL entry.

The defective block found in step **808** may be a newly encountered defective block or a block already listed in the SDL. If the defective block is not listed in the SDL, the defective block is new and the location information regarding the defective block is listed in the SDL entry by setting the LRC bit to 1, such as (1, blkC, 0) shown in FIG. 7D. If the defective block is listed in the SDL, the SDL is corrected by setting the LRC bit to 1 and maintaining the information regarding the replacement block, such as (1, blkC, blkG) shown in FIG. 7C. Such procedure is performed, until the recording of data by the write command of the host is completed. If the writing is completed (**806**), the controller **607** transmits a command execution report to the host (**816**).

When the data is determined to require real time playback, the apparatus starts to read the data from a location of the LBA designated by the host (**804**). As in the recording, a determination is made whether reading of data is completed (**806**). However, if a defective block is found when the reading of data is not completed (**808**), the defective block may skipped, a partially correct data may be read from the defective block or zero padding data may be returned (not shown in FIG. 8A). Information regarding the skipped defective block is entered in the SDL (**812**) and sent to the host (**814**). Such procedure is performed until the playback of data by the read command of the host is completed. If the reading is completed (**806**), the controller **607** transmits a command execution report to the host (**816**).

During recording/playback, the controller **607** may send the information regarding the defective block to the host in various ways. For example, the defective block information can be embedded in a header for transmission to the host, or a new command allowing recognition of the skipped block can be generated and transmitted to the host, or the defective block information may be transmitted together with the command execution report to the host after completing the recording/playback of the real time data.

If it is determined that the data to be recorded does not require real time recording in step **802**, namely the data is PC-data, the controller **607** writes/reads the data starting on/from the LBA designated by the host (**820**). If a read command is received, the playback is carried out starting from the LBA designated by the host and if a write command is received, the recording is carried out starting from the LBA designated by the host. When writing/reading of data is not completed (**822**) and if a defective block is found (**824**), a determination is made whether the defective block is listed in the SDL (**826**).

If the defective block is not listed in the SDL, a replacement block from the spare area is assigned. Thus, the spare full flag is checked to determine whether there are any available replacement blocks, i.e. whether the spare area is full (**828**). A spare full flag of 1 indicates that there are no available replacement blocks. If there are no available replacement blocks, the LRC information in the SDL is set to 1, the location information of the defective block is listed and the location information of the replacement block is set to 0, such as (1, blkC, 0) shown in FIG. 7D (**830**). The information on defective block is transmitted to the host (**832**) and a report of an error in the recording/playback process is sent to the host (**834**).

If the spare area is not full during writing of data, a replacement block is assigned and the data to be written in the defective block is written in the replacement block (**836**). Also, the location information of the defective block and the replacement block is listed in the SDL and the LRC information in the SDL is set to 0, such as (0, blkC, blkG) shown in FIG. 7B (**836**). The information on defective block is transmitted to the host (**838**) and the process returns to step **820** to record more data (**840**).

During reading of data, even if there are available replacement blocks, data cannot be read from the defective block. Accordingly, a report of an error, in the playback is sent to the host (**840**). However, the information on the defective block may be transmitted to the host for future use (**838**) and a replacement block may even be assigned for use in the next recording (not shown). If a replacement block is assigned, the location information of the defective block and the replacement block is listed in the SDL and the LRC information in the SDL is set to 0 in step **836**.

If the defective block is listed in the SDL, a further determination is made whether a replacement block has been assigned (**842**). Namely, if the LRC bit is 0, the SDL entry was made previously while recording/playback of data according to the linear replacement algorithm. Thus, the recording/playback is continued according to the linear replacement algorithm (**844**) and the process returns to step **820** for more recording/playback of data. In other words, if a replacement block is assigned to the SDL entry, the optical pickup is moved to the replacement block and the data is written/read in/from the replacement block. If the LRC bit of the SDL entry is 1 and a replacement block is listed, such as (1, blkC, blkG) shown in FIG. 7C, the listed replacement block is used to perform the linear replacement and the LRC bit is corrected to 0, making the SDL entry to (0, blkC, blkG) shown in FIG. 7B.

If the assigned replacement block is defective, a new replacement block may be assigned according to the direct pointer method and the data is then written/read in/from the assigned replacement block. However, if the spare area becomes full prior to the DMA and there is no replacement block to be assigned, the location information of the defective block of the SDL entry is maintained and the LRC bit is changed into 1, such as (1, blkC, 0) shown in FIG. 7D, indicating not to execute the linear replacement.

If a replacement block has not been assigned in the SDL entry, the spare full flag is checked to determine whether there are any available replacement blocks (**846**). Namely, if the LRC bit of the SDL entry is set to 1, the SDL entry may

have been made while data was written/read according to the skipping algorithm or while the spare area was full. Accordingly, if there are no available replacement blocks, i.e. the spare area is full, a report of a write/read error in the recording/playback process is sent to the host (**834**). However, when formatting an optical disc whose spare area is full, the SDL may be moved to the PDL depending upon the formatting method, such that the spare area may no longer be full. In any case, if the spare area is not full, the process is the same as when the spare area is not full for defective blocks not listed in the SDL (**836–840**).

The above procedure for non real time data is carried out until the recording/playback of data by the writing/reading command of the host is completed. If the writing/reading is completed, the controller **607** sends a command execution report to the host (**848**). Here, the controller **607** sends the information regarding the skipped defective block to the host in the various methods as described above with reference to FIG. **8**A, step **816**.

In a second embodiment of the present invention, the definition of the FRM is changed to distinguish a linear replacement from a skipping replacement. If a defective block blkC is found while recording data according to the skipping algorithm in real time, the SDL entry is listed as (0, blkC, 0) shown in FIG. **9**. At this time, a replacement block is not needed, so the information regarding the replacement block in the spare area is not changed or is listed as 0. Only the definition of the FRM changes.

For example, if FRM and the replacement block are both 0, it is modified to be recognized as indicating a defective block found while performing the skipping algorithm or as indicating an assigned replacement block rather than a defective case of performing the linear replacement. This is because the defective block, even if found during the real time recording, is skipped and a replacement block for the defective block does not exist in the spare area. In addition, this aims at distinguishing the SDL entry listed according to the skipping algorithm from the SDL entry listed according to the linear replacement algorithm. Even under the condition that the area between B and C in FIG. **4**A was listed according to the linear replacement algorithm and the defective block information such as (0, blkC, blkG) was kept as the SDL entry, if the area is used for rewriting according to the skipping algorithm, the SDL entry is modified into (0, blkC, 0).

In sum, the present invention has the following advantages. Primarily, since the controller can detect existence/non-existence of the linear replacement based upon the LRC bit assigned to each SDL entry, the optical disc R/P apparatus (namely, a drive) can transmit the correct information to the host. Accordingly, even if incorrect data of skipped blocks, namely previous data written in the skipped blocks is reproduced by the optical disc R/P apparatus and transmitted to the host during the reproduction of data, the host discards the data of the skipped blocks and reads only the data of normal blocks based upon the defective block information received from the controller. In other words, the present invention can prevent an error occurring when the host does not know the information regarding the skipped blocks.

Also, even if a defective block listed in the SDL is found while carrying out the playback command from the host, the controller can distinctly determine whether to find a replacement block or to discard the defective block and return only an error message to the host. Finally, when a defective block requiring a new replacement block is found while recording or playing back data under while the spare area is full, instead of carrying out the linear replacement, the LRC bit is set in the SDL entry along with the location information of the defective block to indicate that the corresponding SDL entry was made when the spare area was full, whereby the data is not written in the defective block or data of the defective block is not read when rewriting or reproducing the data afterwards. Consequently, the present invention allows efficient management over the disc and increases durability of the disc.

The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teachings can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.

What is claimed is:

1. An optical recording medium, comprising:

a defective management area for managing defective blocks of the optical recording medium; and

a spare area for replacing a defective block, wherein an area in the defective management area records identification information, wherein said identification information includes a first indicator indicating whether or not a defective block is replaced with a replacement block of the spare area, and a second indicator indicating location information of the defective block, wherein said first indicator of said identification information is set to a value at least depending upon a data type to be written or read and/or whether or not a spare block in the spare area remains.

2. An optical recording medium of claim **1**, wherein said area to record the identification information is assigned in an area of a secondary defective entry in said defective management area.

3. An optical recording medium of claim **1**, wherein said defective block is listed in a secondary defect list of the defective management area.

4. A method for managing defective blocks of an optical recording medium, comprising:

(a) determining whether or not to replace a defective block with a replacement block upon finding of the defective block during a writing or reading of data to or from the optical recording medium, based upon a data type to be written or read and/or whether or not an available spare block remains; and

(b) storing indication information indicating whether or not the defective block is replaced with a replacement block, based upon results of said step (a).

5. A method of claim **4**, wherein in said step (a), the defective block is not replaced with a replacement block during a real time writing of data.

6. A method of claim **5**, wherein said step (b) includes:

setting the indication information to indicate that the defective block is not replaced with a replacement block when writing or reading real time data.

7. A method of claim **4**, wherein in said step (b), the indication information is set to indicate that the defective block is not replaced if there is no available spare block.

8. A method of claim **4**, wherein in said step (b), the indication information is stored together with position information of the defective block in a secondary defective list (SDL) of a defective management area.

9. A method of claim **4**, wherein in said step (a), if the data type to be written or read is real time data or if there is no available spare block, said method further comprising:

setting the indication information to indicate that the defective block is not replaced with a replacement block, and storing location information of the defective block and location information of a replacement block without a designated value.

10. A method of claim **4**, wherein in said step (a), if the data type to be written or read is non real time data and if there is an available spare block, said method further comprising:

assigning a replacement block to the defective block;

writing data to the replacement block assigned to the defective block; and

setting the indication information to indicate that the defective block is replaced with a replacement block, and storing location information of the defective block, and location information of the replacement block assigned to the defective block.

11. A method of claim **4**, wherein the indication information is transmitted to a host.

12. A method of claim **11**, wherein the indication information is embedded in a header for transmission to the host.

13. A method of claim **11**, wherein the indication information is transmitted together with a command execution report to the host after recording of the data.

14. An apparatus for recording data, said recording apparatus comprising:

a storage unit storing location information of defective blocks and identification information indicating whether or not the defective block is replaced with a replacement block, the indication information being set based upon a type of data to be written or read and/or whether or not there is a spare block;

a controller determining whether to write or read data in or from a replacement block assigned to the defective block based on the location information and the identification information stored in the storage unit; and

an optical pickup for writing or reading data to or from an optical recording medium according to a control of the controller.

15. An optical recording medium including a spare area for replacing a defective block, comprising:

a defect managing region including:

a first region for storing information regarding a region where a defect is generated;

a second region for storing information regarding a replacement region which substitutes for the region where the defect is generated; and

a third region having indication information for indicating whether or not a linear replacement to the replacement region has been performed, wherein the indication information is set to a value depending upon whether data to be written or read is real time data or non real time data, and/or whether or not there is a remaining spare block of the spare area on a basis of status information to indicate whether or not the spare area is full.

16. An optical recording medium of claim **15**, wherein the information in the second region has a zero address and the indication information in the third region has a value to indicate that the defect region has not been replaced, if the data is real time data or there is no remaining spare block.

17. An optical recording medium of claim **15**, wherein the information in the second region has designated position information of the replacement region and the indication information in the third region has a value to indicate that the defect region has been replaced with a spare block, if the data is non-real time data and there is a remaining spare block.

18. A method for managing a defective area in a recording medium, comprising the steps of:

discriminating whether or not data to be written or read is real time data;

controlling a recording or reproducing operation such that a defective area is not replaced with a spare unit of a spare area if the data is real time data, while the defective area is replaced with a spare unit of the spare area if the data is not real time and if a spare unit to replace the defective area exists in the spare area based on status information to indicate whether or not the spare area is full; and

recording indication information to indicate whether or not the defective area is replaced based on a result of the controlling step.

19. A method of claim **18**, wherein the recording step further records position information of the defective area and position information of the spare unit in the specific area of the recording medium.

20. A method of claim **18**, wherein the indication information is set to a value to indicate that the defective area is not replaced with a spare unit of the spare area if the data is real time data.

21. A method of claim **18**, wherein the indication information is set to a value to indicate that the defective area is replaced with a spare unit of the spare area if the data is not real time data.

22. A defect management method of a recording medium having defect management information within a defect management area for managing a defective block, said method comprising:

(a) skipping a defective block and writing the data in a normal block following the defective block if the defective block is found during a real time recording; and

(b) storing a position of the skipped defective block and identification information indicating that the defective block is not replaced with a spare block, to the defect management information.

23. An apparatus for recording or reading data to or from a recording medium, said apparatus comprising:

a pickup for writing or reading data to or from the recording medium; and

a controller for controlling a recording or reading operation such that a defective block is replaced with a spare block of a spare area of the recording medium or the defective block is not replaced with a spare block of the spare area, based upon whether data to be written or read is real time data or non real time data and/or whether or not a spare block of the spare area remains.

24. An apparatus of claim **23**, wherein the controller controls the pickup to write to an area of the recording medium information for indicating whether or not the defective block is replaced with a spare block of the spare area.

25. A recording medium, comprising:

a spare area for replacing a defective area; and

a defect management area for managing a defective area, the defect management area including first information for indicating a position of a defective area, second information for indicating a position of a replacement area within the spare area to replace a defective area, and third information for indicating whether or not a defective area is replaced with a replacement area within the spare area, thereby at least to control a playback or recording of data in the defective area, wherein the third information is set to a value depend-

ing upon whether data to be written or read is real time data or non real time data, and/or whether or not there is a remaining replacement area within the spare area.

26. A recording medium of claim **25**, wherein the third information is set to a value to indicate that a defective area is not replaced with a replacement area within the spare area if the data to be written or read is real time data.

27. A recording medium of claim **25**, wherein the third information is set to a value to indicate that a defective area is replaced with a replacement area within the spare area if the data to be written or read is non real time data and if a replacement area within the spare area remains.

28. A recording medium of claim **25**, wherein the defect management area includes a primary defect list (PDL) which includes a defective area found during manufacturing or formatting of the recording medium, and a secondary defect list (SDL) which includes a defective area found after formatting of the recording medium, wherein the secondary defect list includes the first, second and third information.

29. A method for managing a defective area of a recording medium, said method comprising:

(a) determining whether or not to replace a defective unit with a spare unit within a spare area of the recording medium, based upon whether or not real time processing of data is required and/or whether or not there is an available spare unit; and

(b) recording indication information indicating whether or not the defective unit is replaced with a spare unit, based upon a result of said step (a).

30. A method of claim **29**, wherein in said step (a), the defective unit is not replaced with a spare unit if a real time processing of data is required.

31. A method of claim **30**, wherein in said step (b), the indication information is set to a value to indicate that the defective unit is not replaced.

32. A method of claim **29**, wherein in said step (a), the defective unit is replaced with a spare unit if a real time processing of data is not required and an available spare unit remains within the spare area.

33. A method of claim **32**, wherein in said step (b), the indication information is set to a value to indicate that the defective unit is replaced with a spare unit.

34. A method for managing a defective area of a recording medium, said method comprising:

(a) checking whether or not a data type to be written or read is real time data and/or whether or not a spare block of a spare area remains; and

(b) determining whether or not to replace a found defective block with a spare block within the spare area for the defective block, based upon a result of said step (a).

35. A method of claim **34**, further comprising:

(c) recording indication information indicating whether or not the defective block is replaced with a spare block, based upon a result of said step (b).

36. A method of claim **34**, wherein in said step (b), the defective block is not replaced with a spare block if the data type is a real time data or if there is no spare block remaining in the spare area.

37. A method of claim **35**, wherein in said step (b), the defective block is not replaced with a spare block if the data type is a real time data or if there is no spare block remaining in the spare area, and wherein in said step (c), the indication information is set to a value to indicate that the defective block is not replaced.

38. A method of claim **34**, wherein in said step (b), the defective block is replaced with a spare block if the data type is non-real time data and there is a spare block within the spare area for the defective block.

39. A method of claim **35**, wherein in said step (b), the defective block is replaced with a spare block if the data type is non-real time data and there is a spare block within the spare area for the defective block, and wherein in said step (c), the indication information is set to a value to indicate that the defective block is replaced with a spare block.

40. A method of claim **34**, wherein the status of the spare area is checked to determine whether or not the spare area is full.

41. A recording medium, comprising:

a data area which includes a defective area;

a spare area for replacing the defective area; and

a defect management area for managing the defective area, the defect management area including first information for indicating a position of the defective area, and second information for indicating a position of a replacement area within the spare area to replace the defective area, wherein the defective area is replaced with a spare unit of the spare area or not replaced, depending upon whether data to be written or read to or from the defective area is real time data or non real time data and/or whether or not there is a remaining spare unit within the spare area, thereby at least to control a playback or recording of data in the defective area.

42. A recording medium of claim **41**, wherein the defective area is not replaced with a spare unit within the spare area if the data to be written or read to or from the defective area is real time data.

43. A recording medium of claim **41**, wherein the defective area is replaced with a spare unit within the spare area if the data to be written or read to or from the defective area is non real time data and if a spare unit within the spare area remains.

44. A method for managing defects in an optical recording medium, wherein the optical recording medium comprises a defect management area including a first region for storing information regarding a defective block, a second region for storing information regarding a replacement block which substitutes for the defective block, and third region having indication information for distinguishing whether or not the defective block is replaced, the method comprising the steps of:

(a) reading data from the optical recording medium; and

(b) upon encountering a defective block, determining whether or not to read data from a replacement block for the defective block, based on the indication information of the third region.

45. A method of claim **44**, further comprising:

(c) reading the data from the replacement block for the defective block, if the indication information indicates that the defective block is replaced, based on the determining step (b).

46. A method of claim **45**, further comprising:

(d) reading the data from a next non-defective block, if the indication information indicates that the defective block is not replaced.

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EXHIBIT C

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(54) **APPARATUS AND METHOD FOR CONTROLLING RECORDING AND REPRODUCTION IN DIGITAL VIDEO CASSETTE TAPE RECORDER**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

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(52) **U.S. Cl.** **386/68**; 386/80; 386/81; 386/95; 386/109; 386/111

(58) **Field of Search** 348/411; 386/6–8, 386/33, 68–70, 78–82, 95, 111–112, 109; 360/10.1, 10.2, 10.3, 32, 48, 18; 369/47–54, 124, 32, 53.29, 47.54, 59.25; 370/394; H04N 5/76, 5/92, 9/79, 5/91

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,651,227 A * 3/1987 Yunoki et al. 358/335

4,663,673 A * 5/1987 Doutsubo 360/10.2

(Continued)

FOREIGN PATENT DOCUMENTS

DE 3437182 * 4/1986 ..... H04N/5/91
DE 3831277 * 3/1990 ..... H04N/5/91

(Continued)

OTHER PUBLICATIONS

Int'l Organization for Standardization, ISO/IEC JTC1/SC29/WG11 MPEG 93/251, Jill Boyce et al. "Fast Scan Technology for MPEG Video Tape Recorders", Mar. 1993.*

Primary Examiner—Thai Tran

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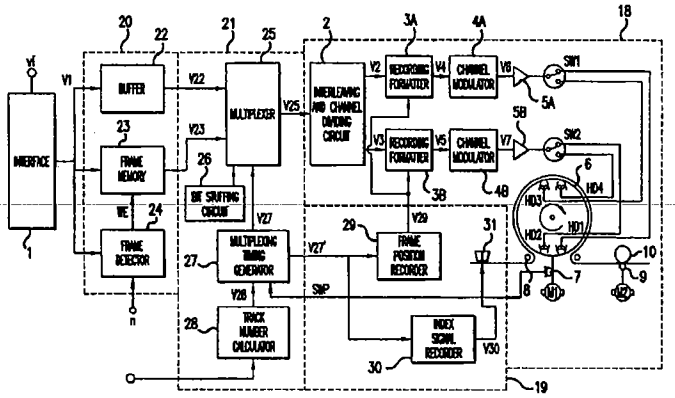
(57) **ABSTRACT**

An apparatus and method for controlling recording and reproduction in a video cassette tape recorder are disclosed. *The* apparatus is capable of, in a recording mode, separating specific data for speed-varied reproduction from compressed digital video signals, recording them on designated tracks, recording position information of the designated tracks on a control track by an index head or recording position information of recording position-synchronized blocks at the starting portions of the designated tracks recorded with the specific data, and in a speed-varied reproduction mode, controlling a capstan servo speed so as to maintain the travel of a magnetic tape at a normal speed and periodically or non-periodically accelerate or decelerate it where specific data for varied-speed have been recorded periodically or non-periodically on predetermined portions of tracks, thereby making heads travel repeatedly at the normal speed and the high speed and thereby detect continuously the specific tracks for varied-speed. A repeatability of reproduced video at a varied speed is obtained without any deterioration in picture quality, because of recording of the specific data for speed-varied reproduction and the continuous detection of the specific data in the speed-varied reproduction.

52 Claims, 10 Drawing Sheets



U.S. PATENT DOCUMENTS

4,802,019	A	*	1/1989	Harada et al.	358/335
5,057,949	A	*	10/1991	Suga et al.	360/10.2
5,122,886	A	*	6/1992	Tanaka	358/335
5,150,210	A	*	9/1992	Hoshi et al.	348/411
5,239,418	A	*	8/1993	Tyler et al.	358/335
5,239,429	A	*	8/1993	Hoshi	
5,247,400	A	*	9/1993	Asai	358/335
5,335,125	A	*	8/1994	Nakatsu et al.	358/335
5,406,382	A	*	4/1995	Adachi	358/335
5,428,393	A	*	6/1995	Enokida	348/390
5,438,458	A	*	8/1995	Honjo	360/10.2
5,488,409	A	*	1/1996	Yuen et al.	348/5
5,504,585	A	*	4/1996	Fujinami et al.	386/111
5,535,008	A	*	7/1996	Yamagishi et al.	386/109
5,589,993	A	*	12/1996	Naimpally	386/81
5,745,641	A	*	4/1998	De Haan et al.	386/95
5,907,446	A	*	5/1999	Ishii et al.	360/72.2

FOREIGN PATENT DOCUMENTS

DE	4037178	*	6/1991	H04N/5/782
EP	0 461 649	*	12/1991	H04N/5/92
EP	0 505 985	*	9/1992	H04N/5/92
EP	0 513 744	*	11/1992	G11B/15/43

* cited by examiner

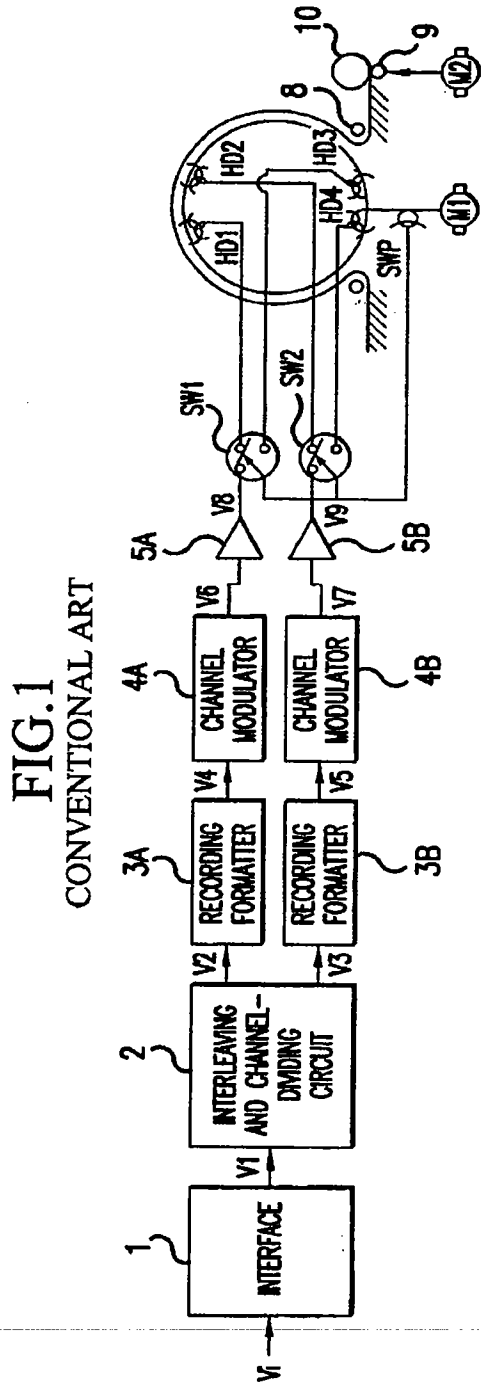


FIG.1
CONVENTIONAL ART

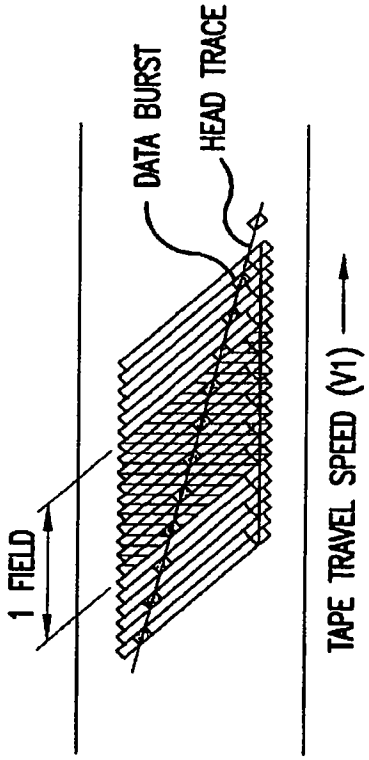


FIG.3
CONVENTIONAL ART

FIG.2
CONVENTIONAL ART

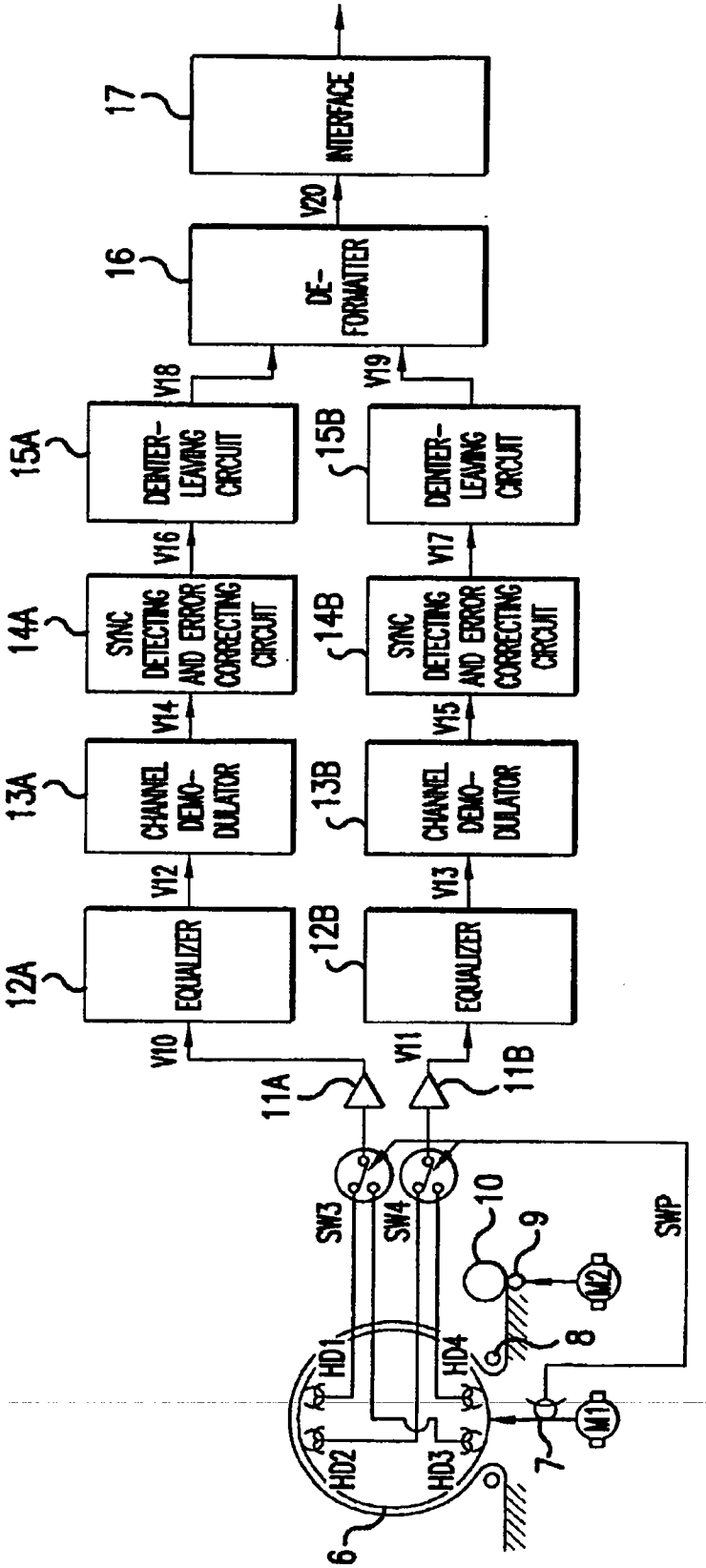


FIG.4

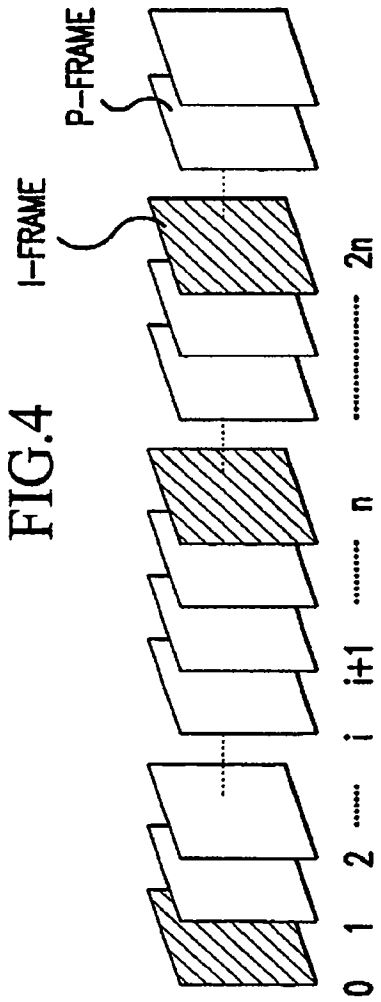

P-FRAME
I-FRAME
0 1 2 ..... i i+1 ..... n 2n

FIG.5

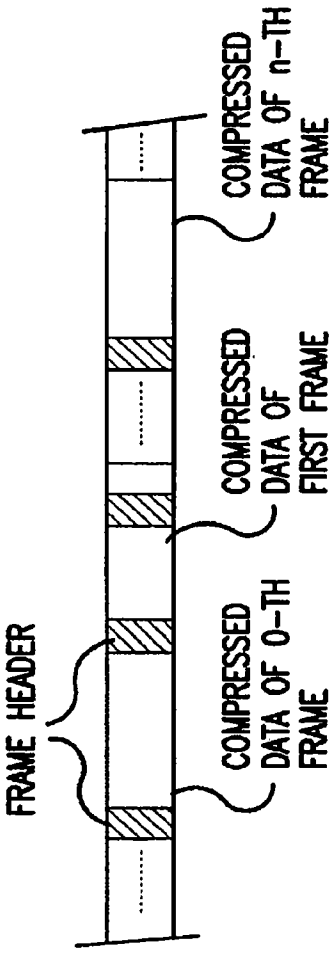

FRAME HEADER
COMPRESSED DATA OF 0-TH FRAME
COMPRESSED DATA OF FIRST FRAME
COMPRESSED DATA OF n-TH FRAME

FIG.6

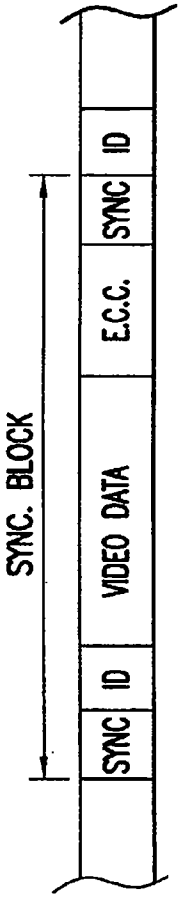

SYNC. BLOCK
SYNC
ID
VIDEO DATA
E.C.C.
SYNC
ID

FIG.9

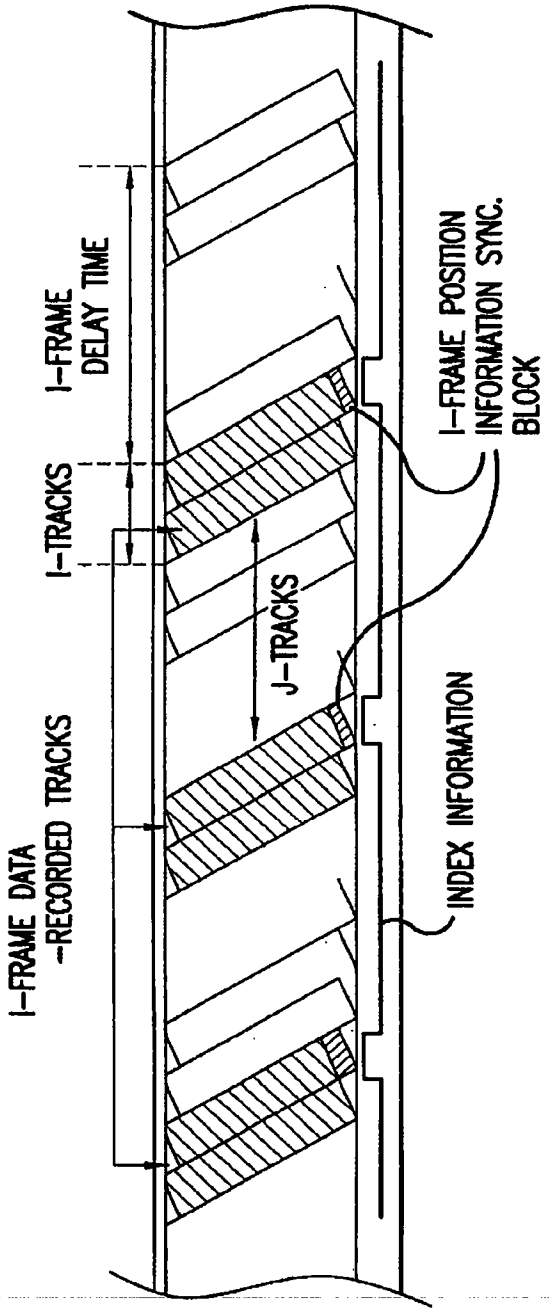

I-FRAME DELAY TIME
I-TRACKS
J-TRACKS
I-FRAME POSITION INFORMATION SYNC. BLOCK
INDEX INFORMATION
I-FRAME DATA -RECORDED TRACKS

FIG.7

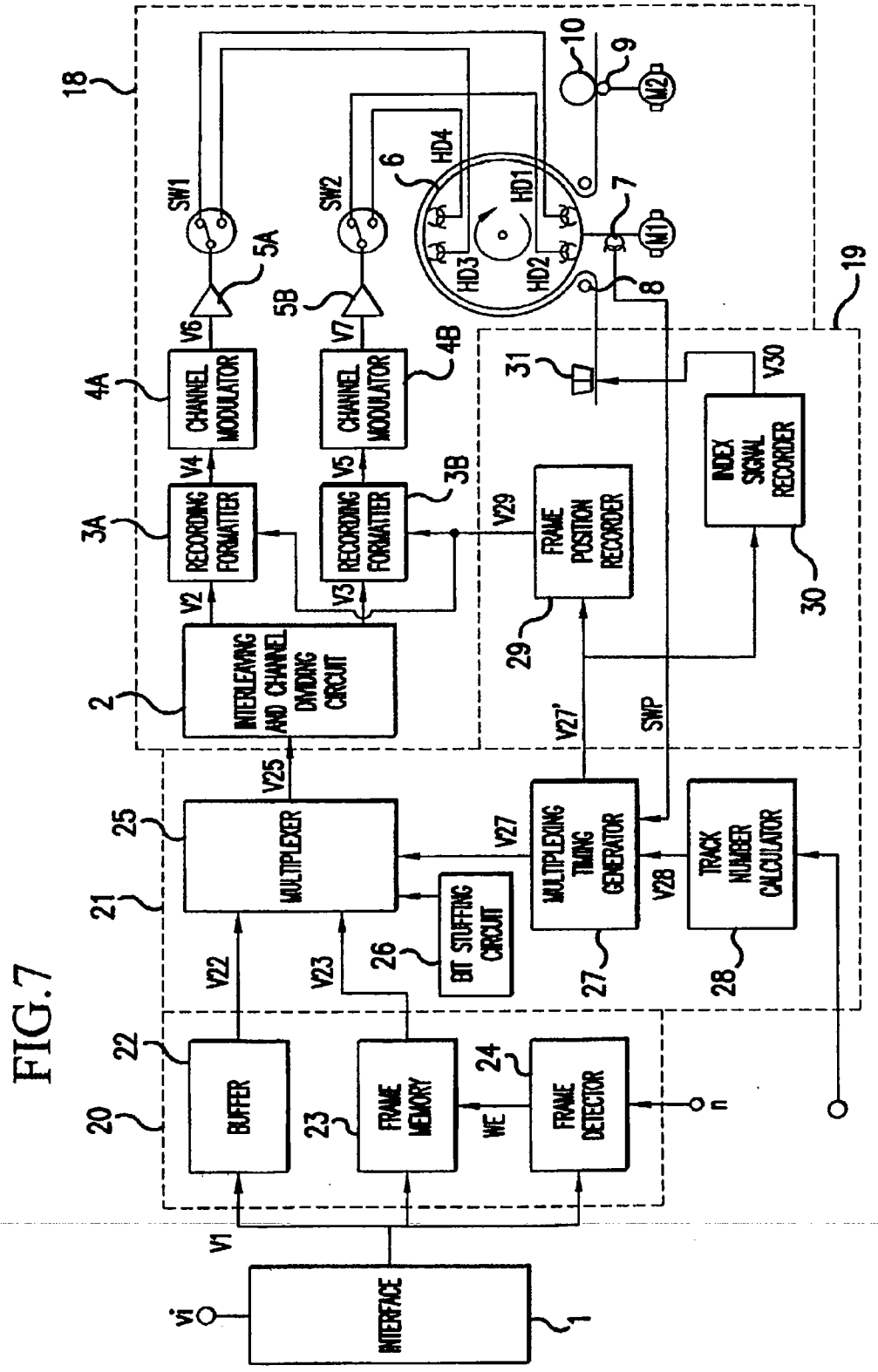
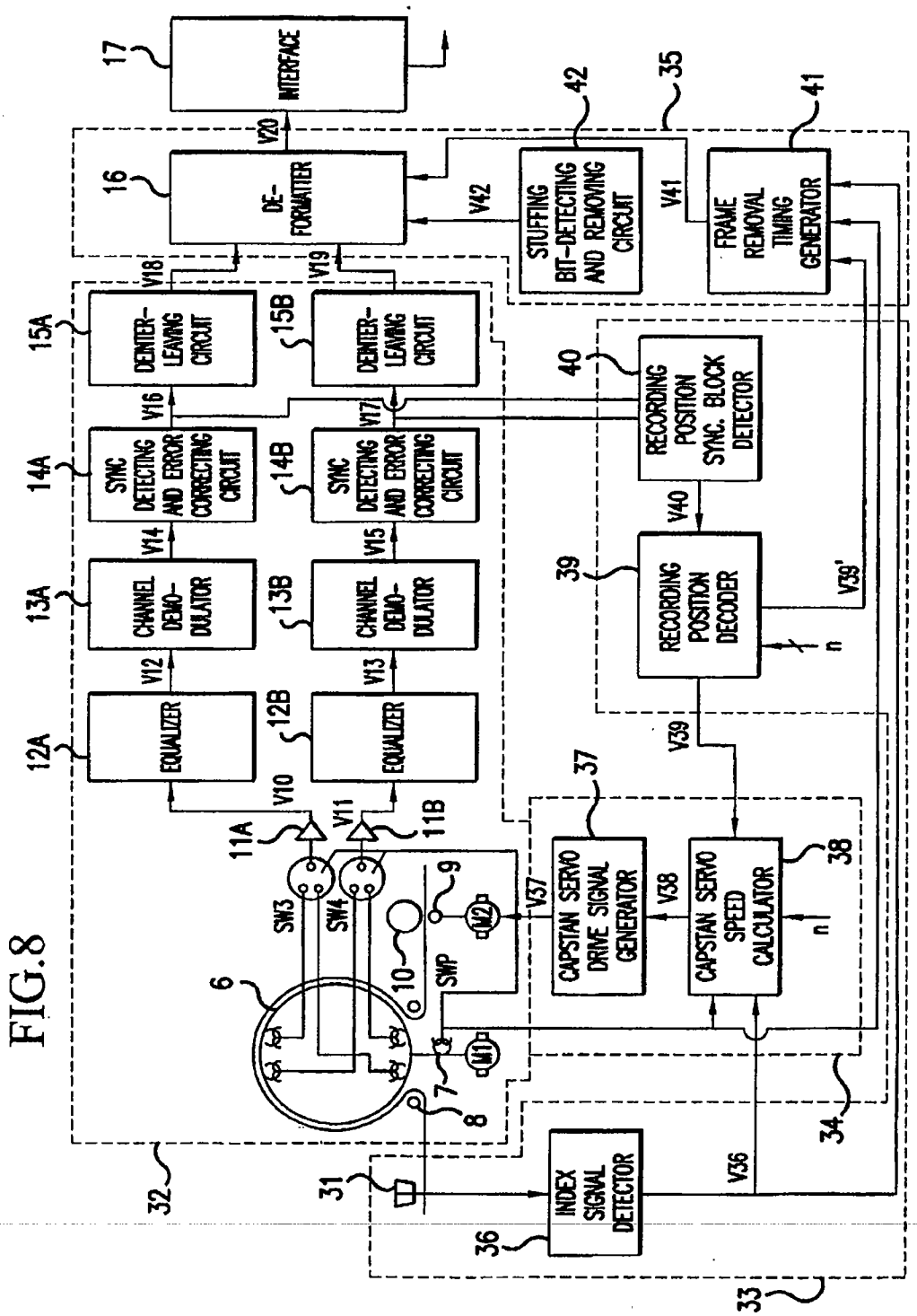

18
19
10
9
M2
SW1
SW2
6
HD4
HD1
HD3
HD2
7
M1
8
5A
5B
V6
V7
4A
4B
CHANNEL MODULATOR
CHANNEL MODULATOR
31
V30
V4
V5
3A
3B
RECORDING FORMATTER
RECORDING FORMATTER
V29
FRAME POSITION RECORDER
INDEX SIGNAL RECORDER
V2
V3
29
30
2
INTERLEAVING AND CHANNEL DIVIDING CIRCUIT
V27'
SWP
V25
25
MULTIPLEXER
V27
MULTIPLEXING TIMING GENERATOR
TRACK NUMBER CALCULATOR
V28
21
BIT STUFFING CIRCUIT
V22
V23
26
27
28
22
24
20
23
BUFFER
FRAME MEMORY
WE
FRAME DETECTOR
n
V1
Vi
INTERFACE
1

FIG.8


17
INTERFACE
V20
16
DE-FORMATTER
V42
42
STUFFING BIT-DETECTING AND REMOVING CIRCUIT
V41
35
41
FRAME REMOVAL TIMING GENERATOR
V18
V19
15A
DEINTER-LEAVING CIRCUIT
15B
DEINTER-LEAVING CIRCUIT
40
RECORDING POSITION SYNC. BLOCK DETECTOR
V16
V17
14A
SYNC DETECTING AND ERROR CORRECTING CIRCUIT
14B
SYNC DETECTING AND ERROR CORRECTING CIRCUIT
V40
V14
V15
13A
CHANNEL DEMO-DULATOR
13B
CHANNEL DEMO-DULATOR
39
RECORDING POSITION DECODER
V39'
n
V12
V13
12A
EQUALIZER
12B
EQUALIZER
V39
V10
V11
37
11A
11B
SW3
SW4
9
M2
V37
CAPSTAN SERVO DRIVE SIGNAL GENERATOR
V38
CAPSTAN SERVO SPEED CALCULATOR
38
n
6
10
SWP
M1
7
8
34
32
31
INDEX SIGNAL DETECTOR
V36
36
33

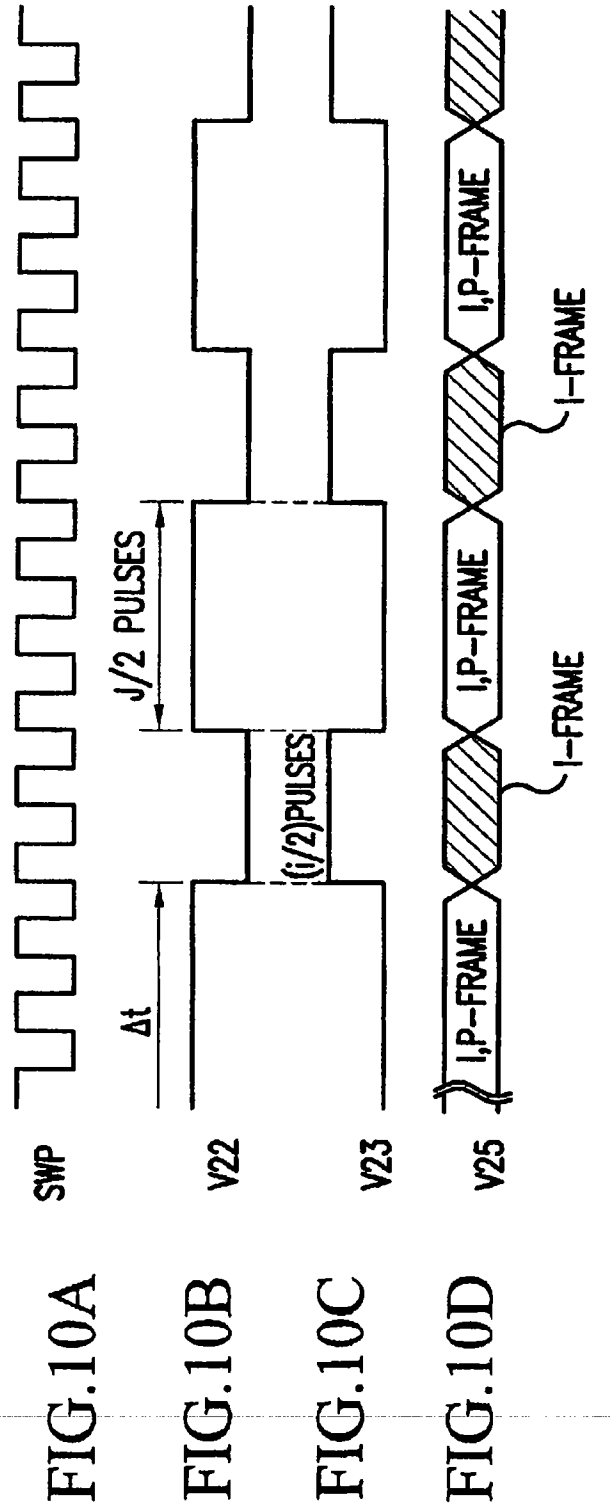


FIG.10A

FIG.10B

FIG.10C

FIG.10D

FIG.11

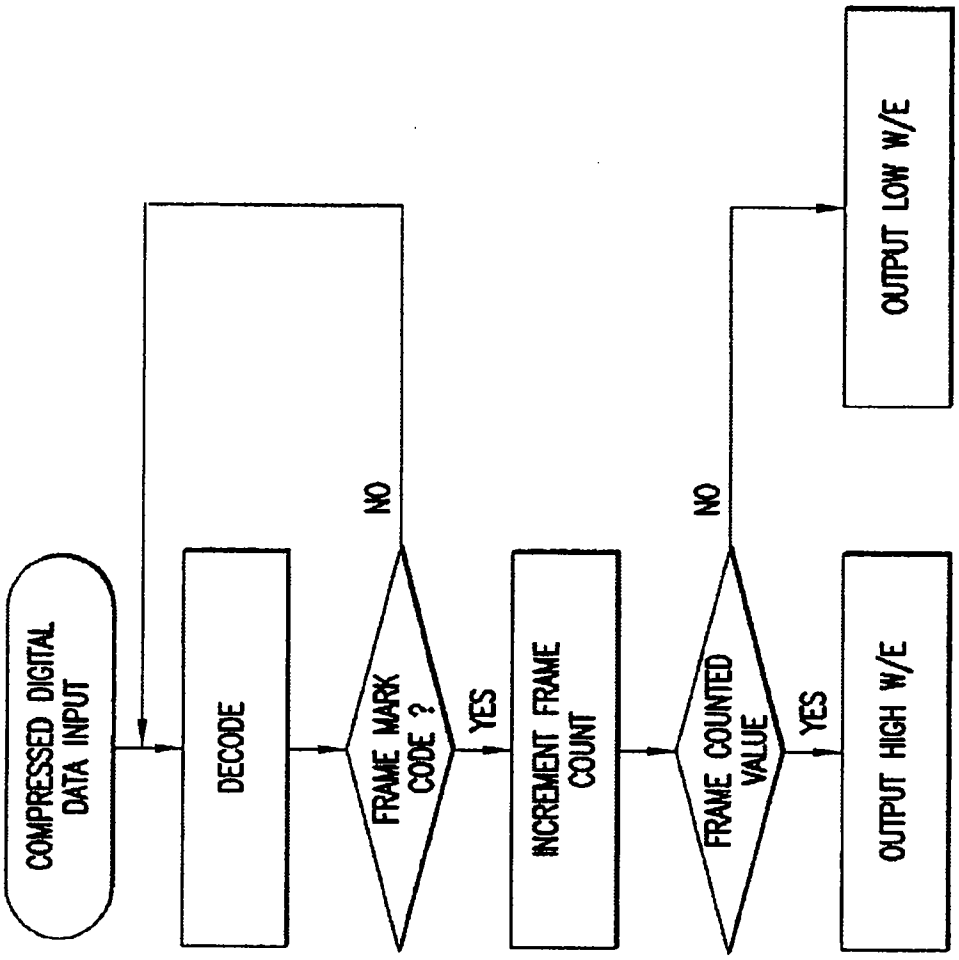

COMPRESSED DIGITAL DATA INPUT
DECODE
FRAME MARK CODE ?
NO
YES
INCREMENT FRAME COUNT
FRAME COUNTED VALUE
NO
YES
OUTPUT LOW W/E
OUTPUT HIGH W/E

FIG.12

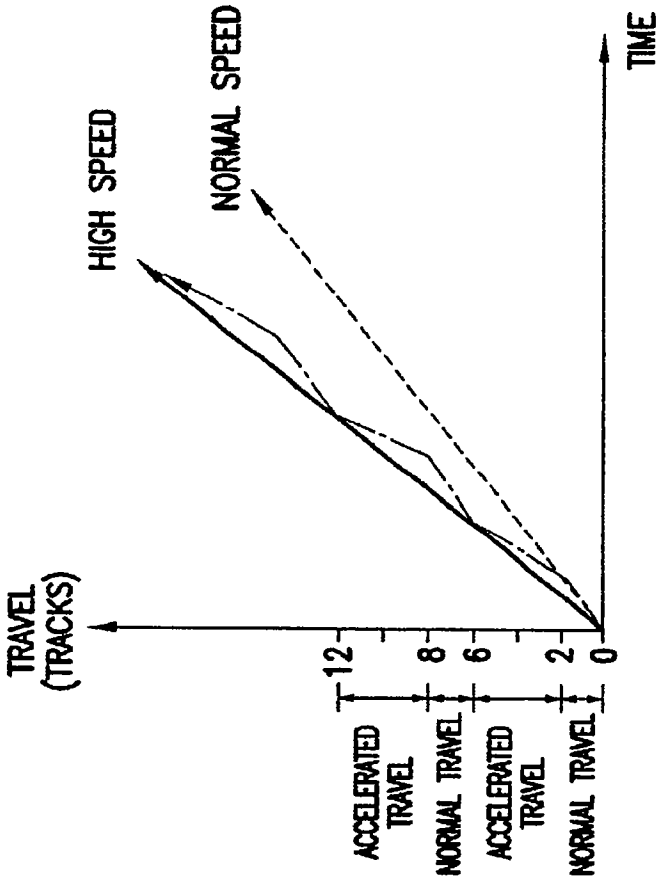


FIG.13A

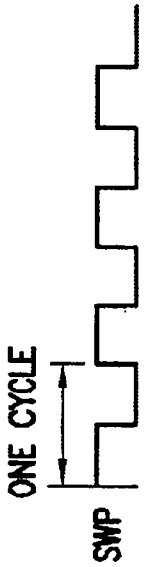


FIG.13B

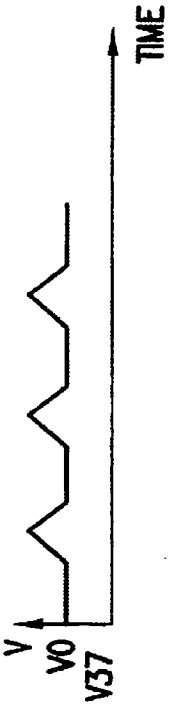


FIG.13C

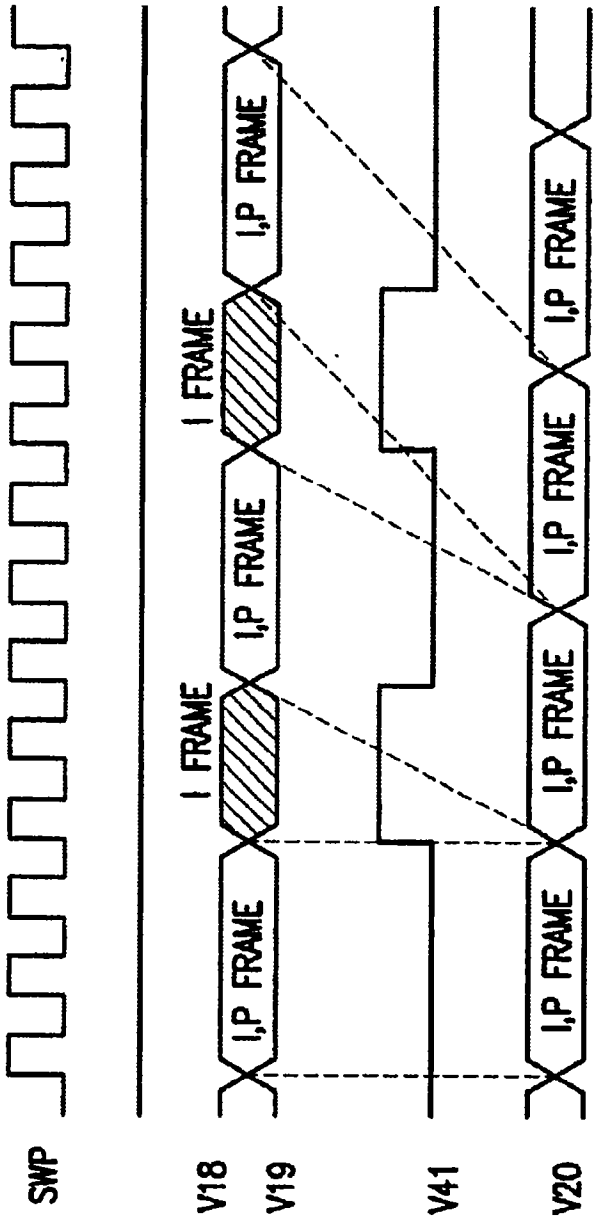


FIG.14A FIG.14B FIG.14C FIG.14D

APPARATUS AND METHOD FOR CONTROLLING RECORDING AND REPRODUCTION IN DIGITAL VIDEO CASSETTE TAPE RECORDER

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

More than one reissue application has been filed for U.S. Ser. No. 08/227,288 filed on Apr. 13, 1994 U.S. Pat. No. 5,587,789. Specifically, application Ser. No. 10/883,196 was filed on Jul. 1, 2004 as a continuation of the present application, Ser. No. 09/118,824.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a circuit device and method for controlling recording and reproduction in a digital cassette tape recorder.

2. Description of the Background Art

For analog/digital conversion for converting an analog video signal into a digital video signal and linear quantization, a signal transmission rate of about 100 Mega bits per second is typically required in the case of a normal TV broadcast signal such as NTSC, SECAM and PAL signals. On the other hand, a high definition TV (HDTV) signal with higher resolution than that of the normal TV broadcast signal requires a signal transmission rate higher than 100 Mega bits.

For achieving data transmission in a limited transmission band, digitalized video signals should be transmitted in the form compressed in accordance with the video data compression-technique. In the case of digital cassette tape recorders (digital VCRs) having a limitation on record bandwidth, signals recorded on a magnetic tape may be digital normal TV signals having the form of compressed signals or digital HDTV signals having the form of compressed signals.

Referring to FIG. **1**, there is illustrated a conventional recording circuit for such a digital VCR. As shown in FIG. **1**, the recording circuit includes an interface **1** for converting a compressed digital video signal into a signal having the recordable form, an interleaving and channel-dividing circuit **2** for interleaving an output V1 from the interface **1** in a predetermined form to reduce burst error and channel-dividing it to be matched with the zero bandwidth of a recording channel, recording formatters **3**A and **3**B for respectively converting outputs V2 and V3 of the interleaving and channel-dividing circuit **2** to record formats each including a synchronous signal, an identification signal and redundancy bits for error correction codes, channel modulators **4**A and **4**B for modulating outputs V4 and V5 of the recording formatters **3**A and **3**B, respectively, recording amplifiers **5**A and **5**B for amplifying outputs V6 and V7 of the channel modulators **4**A and **4**B, respectively, a drum pulse generator **7** for outputting two pulses at every rotation of a head drum **6** caused by driving a drum motor M1, and switches SW1 and SW2 for performing their switching operations based on an output SWP from the drum pulse generator **7** to selectively transmit outputs V8 and V9 of the recording amplifiers **5**A and **5**B to heads HD1 (or HD3) and HD2 (or HD4), respectively. In FIG. **1**, the reference numeral **8** denotes a guide pin, **10** a pinch roller, and **9** a capstan adapted to be rotated by a capstan motor M2.

FIG. **2** is a block diagram illustrating a conventional reproduction circuit for the digital VCR. As shown in FIG. **2**, the reproduction circuit includes reproduction amplifiers **11**A and **11**B for receiving outputs from selected heads HD1 (or HD3) and HD2 (or HD4) mounted on the head drum **6** via the switches SW1 and SW2 switched in accordance with the output SWP from the drum pulse generator **7** and amplifying them, respectively, equalizers **12**A and **12**B for compensating distortions of frequency characteristics of outputs V10 and V11 of the reproduction amplifiers **11**A and **11**B, respectively, channel demodulators **13**A and **13**B for demodulating outputs V12 and V13 of the equalizers **12**A and **12**B, respectively, sync-detecting and error-correcting circuits **14**A and **14**B for detecting synchronous signals SYNC added in a recorded signal from the outputs V14 and V15 of the channel demodulators **13**A and **13**B and correcting errors of the outputs V14 and V15, respectively, deinterleaving circuits **15**A and **15**B for deinterleaving outputs V16 and V17 of the sync-detecting and error-correcting circuits **14**A and **14**B into the original signal form, respectively, a deformatter **16** for recovering outputs V18 and V19 of the deinterleaving circuits **15**A and **15**B to the original signal format, and an interface **17** for converting an output V20 of the deformatter **16** into a reproduced digital signal Vo and outputting it.

Now, operations of the conventional circuits will be described in conjunction with FIGS. **1** to **6**.

First, in a recording mode, a compressed HDTV signal or compressed normal TV signal is applied to the interface **1** which, in turn, converts the received signal into a signal V1 capable of being recorded and reproduced. The signal V1 is then interleaved into a predetermined form to reduce burst errors in the interleaving and channel-dividing circuit **2** which, in turn, outputs signals V2 and V3 channel-divided so as to be matched with the bandwidth of the recording channel.

The outputs V2 and V3 from the interleaving and channel-dividing circuit **2** are applied to the recording formatters **3**A and **3**B and then added with synchronous signals SYNC, identification signals ID and redundancy bits for error correction codes ECC in the recording formatters **3**A and **3**B. Resultant signals from the recording formatters **3**A and **3**B are then received in the channel modulators **4**A and **4**B which, in turn, output signals V6 and V7 matched with a predetermined recording format, respectively. The outputs V6 and V7 from the channel modulators **4**A and **4**B are applied to the recording amplifiers **5**A and **5**B which, in turn, amplify them, respectively.

Outputs V8 and V9 from the recording amplifiers **5**A and **5**B are applied to selected heads HD1 (or HD3) and HD2 (or HD4) via the switches SW1 and SW2 switched by the output SWP from the drum pulse generator **7**, so that they are recorded on a magnetic tape in a recording format shown in FIG. **3**.

In this case, the drum pulse generator **7** generates two pulses at every rotation of the head drum **6** driven by the drum motor M1.

Meanwhile, frames have a mixed form of intra-frames (I-frames) able to be independently decoded and predictive frames (P-frames) compressed by moving information of previous screen and unable to be independently decoded, in accordance with a video compression system for HDTV signals or an MPEG (Moving Picture Experts Group) system. Bit rate generated in each frame is non-uniform, as shown in FIG. **5**.

In a reproduction mode, the magnetic tape travels by the rotation of the capstan **9** caused by the capstan motor M2 while being in contact with the head drum **6** rotating by the

driving force of the drum motor M1. At this time, the heads HD1 (or HD3) and HD2 (or HD4) detect signals on the magnetic tape and send them to the reproduction amplifiers 11A and 11B via the switches SW3 and SW4 switched by the output SWP of the drum pulse generator 7, respectively.

The signals received in the reproduction amplifiers 11A and 11B are amplified to a predetermined level and then sent to the equalizers 12A and 12B which, in turn, output signals V12 and V13 having compensated frequency characteristics, respectively. The signals V12 and V13 from the equalizers 12A and 12B are then applied to the channel demodulators 13A and 13B, respectively, so as to be demodulated. Outputs V14 and V15 from the channel demodulators 13A and 13B are received in the sync-detecting and error-correcting circuits 14A and 14B which, in turn, detect respectively synchronous signals SYNC and identification signals ID from synchronous block of the received signals and remove error components included in the data.

Outputs V16 and V17 from the sync-detecting and error-correcting circuits 14A and 14B are applied to the deinterleaving circuit 15A and 15B which, in turn, deinterleave the signals V16 and V17 and thereby generate signals V18 and V19 having the original signal forms, respectively. The signals V18 and V19 are received in the deformatter 16 and thereby converted to the format having the signal form prior to recording. Signal V20 from the deformatter 16 is applied to the interface 17 which, in turn, generates a reproduced digital signal Vo.

In a speed-varied reproduction, the rotation speed of the head drum 6 is kept constant while the travel of the magnetic tape is accelerated. As a result, the heads HD1 to HD4 travel across tracks on the magnetic tape. The trace of the heads is shown in FIG. 3. Consequently, the detected signals have a discontinuous data form, namely, data burst with a magnitude inversely proportional to the travel speed of the magnetic tape.

In the case of existing analog VCRs, data of one field are recorded in one track in the reproduction order. Accordingly, regions on tracks from which data are detected in the speed-varied reproduction mode are directly associated with reproduction regions of a corresponding screen. Therefore, video reproduction in the speed-varied mode is possible even when a noise bar is generated due to data detected on an adjacent track.

In the case of existing digital VCRs, however, data of one field are recorded in a plurality of tracks, as shown in FIG. 3. As a result, reproduction bursts on adjacent tracks have no relation with the reproduction order. In this case, therefore, a frame memory and an addressing process for rearranging data detected are needed. Furthermore, there is a problem of an inevitable mosaic-shaped distortion of small segments due to discontinuous detection of data bursts.

For a video reproduction in the existing digital VCRs, data bursts detected should be independently decoded. However, these data bursts include unrecoverable other data on the screen or unrecoverable previous screen data, because the data bursts have the digital form compressed using the correlation between signals that may be the important factor of adversely affecting the picture quality in reproduction. The unrecoverable data can not be decoded and thereby reproduced in the form of videos. In particular, such a problem becomes more frequent in the case of data obtained from the video compression system such as the variable length coding involving non-uniform data lengths.

In other words, although data bursts detected from tracks on which data of the 0-th I-frame, the n-th I-frame, the 2n-th I-frame . . . are recorded can be constructed to a video, data bursts detected from tracks on which data of P-frames are recorded can not be constructed to a video.

SUMMARY OF THE INVENTION

Therefore, an object of the invention is to provide an apparatus and method for controlling recording and reproduction in a digital VCR capable of, in a recording mode, extracting independently-decodable data, namely, intra-frames from digital signals having a compressed form so as to record them on tracks designated with respect to a number of different tape speeds and, in a speed-varied reproduction mode, repeatedly performing a normal-speed travel and a high-speed travel of a magnetic tape so as to detect specific data for speed-varied reproduction periodically or non-periodically recorded on tracks of the magnetic tape, thereby reproducing videos with improved picture quality.

In accordance with the present invention, this object can be accomplished by providing an apparatus for controlling recording and reproduction in a video cassette tape recorder comprising: frame extracting means for buffering and amplifying compressed digital data input, and extracting specific data for a speed-varied reproduction from the compressed digital data; frame recording position controlling means for calculating the number of tracks for the compressed digital data, selectively outputting a buffered and amplified output and the extracted specific data from said frame extracting means, and outputting a multiplexing timing signal; frame position information recording means for recording position information of tracks for a speed-varied reproduction and index information on a magnetic tape, based on the multiplexing timing signal; digital recording means for recording the digital signals including the index information on the magnetic tape; digital reproduction means for reproducing the digital signals recorded on the magnetic tape; frame position information detecting means for detecting position information of specific tracks for the speed-varied reproduction and index information tape speed controlling means for controlling the speed of a capstan motor, based on the detected index information and position information of the specific tracks; and frame removing means for receiving therein the output from the digital reproduction means and removing unnecessary bit streams from the specific data. Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the invention will become more apparent upon a reading of the following detailed specification and drawings which are given by way of illustration only, and thus are not limitative of the present invention, in which:

FIG. 1 is a block diagram of a conventional recording circuit for a digital VCR;

FIG. 2 is a block diagram of a conventional reproduction circuit for a digital VCR;

FIG. 3 is a schematic view illustrating recording tracks of a magnetic tape and a trace of heads travelling in a speed-varied reproduction mode in accordance with the conventional art;

FIG. **4** is a schematic view illustrating a correlation among frames in accordance with a video compression system;

FIG. **5** is a schematic view illustrating an encoded bit stream;

FIG. **6** is a schematic view illustrating synchronous blocks of a video signal for recording and reproduction;

FIG. **7** is a block diagram of a recording control circuit for a digital VCR in accordance with an embodiment of the present invention;

FIG. **8** is a block diagram of a reproduction control circuit for a digital VCR in accordance with an embodiment of the present invention;

FIG. **9** is a schematic view illustrating recording tracks in accordance with the present invention;

FIGS. **10**A to **10**D are waveform diagrams of signals generated in recording position control;

FIG. **11** is a schematic view illustrating recording position-synchronized blocks in accordance with the present invention;

FIG. **12** is a flow chart illustrating a frame detection procedure in accordance with the present invention;

FIGS. **13**A to **13**C illustrate a capstan servo speed control in accordance with the present invention; and

FIGS. **14**A to **14**D are waveform diagrams of signals generated in frame removal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. **7** and **8**, there is illustrated an apparatus for controlling recording and reproduction in a digital VCR in accordance with an embodiment of the present invention.

FIG. **7** is a block diagram illustrating a recording control circuit device for a digital VCR in accordance with the present invention. As shown in FIG. **7**, the recording control circuit device includes a frame extracting unit **20** for buffering and amplifying an output signal **V1**, namely, compressed digital data, of an interface **1**, and extracting specific data for speed-varied reproduction from the received signal **V1**, a frame recording position controlling unit **21** for selectively outputting an output **V22** of the frame extracting unit **20** obtained after the buffering and amplifying operations and the extracted specific data **V23**, and outputting a multiplexing timing signal **V27'**, a frame position information recording unit **19** for recording track position information and index information for speed-varied reproduction on a magnetic tape, based on the multiplexing timing signal **V27'**, and a digital recording unit for recording the digital data including the index information on the magnetic tape.

In similar to the conventional case, the digital recording unit **18** includes an interleaving and channel-dividing circuit **2**, recording formatters **3**A and **3**B, channel modulators **4**A and **4**B, recording amplifiers **5**A and **5**B, a head drum **6** equipped with heads **HD1** to **HD4**, a drum pulse generator **7** and switches **SW1** and **SW2**. With this construction, the digital recording unit **18** records digital signals including index signals on the magnetic tape. For simplicity of the description, the description concerning the digital recording unit **18** will be omitted.

The frame extracting unit **20** includes a buffer **22** adapted to buffer the output signal **V1** of the interface **1** and thereby amplify it to a predetermined level, a frame detector **24** adapted to detect specific data corresponding to an intraframe, and a frame memory **23** adapted to store the detected specific data.

The frame recording position controlling unit **21** includes a track number calculator **28** adapted to calculate the number of tracks, a multiplexing timing generator **27** adapted to operate an output SWP of the drum pulse generator **7** and thereby generate a multiplexing timing signal **V27**, a bit stuffing circuit *26* adapted to make the output signal **V23** of the frame memory **23** have a constant data length when the output signal **V23** is at an underflow state, and a multiplexer **25** adapted to multiplex the output signals **V22** and **V23** of the frame extracting unit **20** and thereby output a signal **V25**.

On the other hand, the frame position information recording unit **19** includes a frame position recorder **29** adapted to receive the multiplexing timing signal **V27'** from the frame recording position controlling unit **21** and record, on the leading portion of a track for varied speed, position information of a next track for speed change, and an index signal recorder **30** adapted to record index information of a track to be scanned by an index head **31**.

In FIG. **7**, the reference numeral **8** denotes a guide pin, **9** a capstan engaged with a pinch roller **10**, **M1** a drum motor, and **M2** a capstan motor.

FIG. **8** is a block diagram illustrating a reproduction circuit device in accordance with the present invention. As shown in FIG. **8**, the reproduction circuit includes a digital reproduction unit **32** for reproducing compressed digital data recorded on the magnetic tape, a frame position information detecting unit **33** for detecting index information from the magnetic tape and detecting information indicative of the position of a specific track, a tape speed controlling unit **34** for controlling the speed of the capstan motor **M2**, and a frame removing unit **35** for **[a]** removing specific data for speed-varied reproduction during a reproduction at a constant speed.

The digital reproduction unit **32** includes the head drum **6** equipped with the heads **HD1** to **HD4**, the drum pulse generator **7**, switches **SW3** and **SW4**, reproduction amplifiers **11**A and **11**B, equalizers **12**A and **12**B, channel demodulators **13**A and **13**B, and sync-detecting and error-correcting circuit **14**A and **14**B. This construction of the digital reproduction unit **32** is similar to that of the conventional digital reproduction unit shown in FIG. **2**. Therefore, the detailed description concerning the digital reproduction unit **32** will be omitted for simplicity of the description.

The frame position information detecting unit **33** includes an index signal detector **36** adapted to detect index information, a recording position-synchronized block detector **40** adapted to detect, from the outputs **V16** and **V17** of the sync-detecting and error-correcting units **14**A and **14**B, position information of a specific track including specific data recorded, and a recording position decoder **39** adapted to decode the detected position information.

The tape speed controlling unit **34** includes a capstan servo-speed calculating circuit **38** adapted to operate outputs **V36** and **V39** of the frame position frame detecting unit **33**, and a drive signal generator **37** adapted to generate a drive signal **V37** for controlling the speed of the capstan motor **M2**.

Finally, the frame removing unit **35** includes a frame removal timing generator **41** adapted to operate an output of the drum pulse generator **7** and outputs **V36** and **V39'** of the frame position information detecting unit **33** and thereby generate a timing signal for removing specific data for speed-varied reproduction, a stuffing bit-detecting and removing circuit **42** adapted to detect and remove a stuffing

bit added for preventing generation of the underflow of the frame memory **23**, and a deformatter **16** adapted to convert an output of the digital reproduction unit **32** to the format having the signal form prior to recording.

Operations of the apparatus for controlling recording and reproduction in the digital VCR in accordance with the present invention will be described, in conjunction with FIGS. **4** to **14**.

First, in a recording mode, an input signal Vi such as a compressed HDTV signal or compressed normal TV signal is applied to the interface **1** which, in turn, converts the received signal into a signal Vl having the form capable of being recorded and reproduced.

The signal V1 from the interface **1** is then applied to the frame extracting unit **20**. In the frame extracting unit **20**, the received signal V1 is buffered and amplified by the buffer **22**. By the buffering and amplifying operations, the signal V1 is delayed for a predetermined time. The frame detector **24** detects compressed I-frames repeated at intervals of n frames, from a bit stream encoded to have frames with different compressed bit lengths. The frame memory **23** stores data of the detected I-frames.

In other words, compressed digital data of the I-frames repeatedly present at intervals of n frames are separated from the encoded bit stream shown in FIG. **4** and then duplicatively recorded on a specific track because they can be independently decoded. A write enable signal W/E of high level is applied to the frame memory **23** only for the period of detecting I-frames from the encoded bit stream by the frame detector **24**. As a result, the frame memory **23** can store only the compressed video data of the I-frames.

This procedure for detecting I-frames will be described in detail, in conjunction with FIG. **12**. An input bit stream is received in the frame detector **24** and then decoded. The frame detector **24** detects a frame mark code from a header of each frame in the bit stream. When the frame mark code is detected, an increment in frame counted value is carried out. If I-frames are present at intervals of n frames, it is determined whether the number of counted frames equals a multiple of n (i.e., k*n, where k=0, 1, 2, . . .). When the (n*k)th is detected, a write enable signal W/E of high level is applied to the frame memory **23**, thereby enabling compressed digital data bits of a corresponding I-frame to be stored. When a next frame mark code is detected, a write enable signal W/E of low level is applied to the frame memory **23**. As a result, it is possible to prevent frames of the frame bit stream other than I-frames from being stored.

The frame recording position controlling unit **21** sends selectively I-frame data V23 and record data V22 outputted from the frame extracting unit **20** to the digital recording unit **18** at a predetermined timing. Accordingly, a recording format shown in FIG. **9** is formed in the digital recording unit **18**.

On the other hand, since the lengths of compressed data of frames are non-uniform, the frame memory **23** may encounter an underflow phenomenon that data stored in the frame memory **23** at the moment an I-frame is recorded in the frame memory **23** is insufficient or an overflow phenomenon that data stored in the frame memory **23** prior to recording of an I-frame is full.

This will be descried in detail. Assuming that the average bit rate of input data received in the interface **1** is R and the size of regions of the input data occupied by I-frames is α, the average bit rate of data to be recorded is expressed by $R+\alpha R$. This average bit rate of data is calculated in the track number calculator **28**. In this case, α can be calculated from α=the number of tracks i for I-frames/ the number of tracks j for P-frames. Here, the number of tracks, i, is generally determined by the average bit rate of I-frames.

The multiplexing timing generator **27** operates an output V28 of the track number calculator **28** which calculates the number of I-frame tracks, i, and the number of P-frame tracks, j. The multiplexing timing generator **27** also operates the output SWP of the drum pulse generator **7**. By these operations, a reference pulse is calculated. One pulse of the output SWP of the drum pulse generator **7** corresponds to a recording period for one track in a case of recording one-channel data and to a recording period for two tracks in a case of recording two-channel data. Accordingly, the multiplexing timing generator **27** outputs a switching signal V27 enabling the multiplexer **25** to selectively output data V23 for double speed stored in the frame memory **23** and normally-recorded data (FIG. **10**B) buffered and amplified by the buffer **22**, as shown in FIG. **10**D.

In the output V22 from the buffer **22** shown in FIG. **10**B, Δt represents the period for delaying outputting of I-frames present between the first recording track and a predetermined track so as to prevent an underflow phenomenon. In the worst case where an underflow phenomenon occurred in the frame memory **23**, the bit stuffing unit **26** performs a bit stuffing operation for adding, to data of I-frames, escape synchronous codes and dummy bits capable of being detected in reproduction, so as to generate data having a constant length. On the other hand, where an overflow phenomenon occurred in the frame memory **23**, a write enable signal W/E of low level is applied from the frame detector **24** to the frame memory **23** for a predetermined period.

In the frame position information recording unit **19**, the frame position recorder **29** and the index signal recorder **30** receive the output V27' from the multiplexing timing signal generator **27** of the frame recording position controlling unit **21**. The frame position recorder **29** outputs information V29 based on its frame position discrimination to the recording formatters **3**A and **3**B. Based on the information V29, the recording formatters **3**A and **3**B form a synchronous block including information indicative of the position of a track including a next I-frame recorded, in each video data region. The recording formatters **3**A and **3**B also record the recording position information in the first synchronous block recording position of the tracks including I-frames recorded, as shown in FIG. **9**. Here, the recording position information represents the code converted from the number of tracks present between the track including the current I-frame recorded and the track including the next I-frame recorded, as shown in FIG. **11**.

On the other hand, the index signal recorder **30** outputs index information V30, namely, a pulse indicative of whether an I-frame has been recorded or not, to the index head **31** which, in turn, records the index information V30 on a control track.

The above-mentioned overall operations will be described in detail. As the head drum **6** carrying the heads HD1 to HD4 is rotated by the driving force of the drum motor M1 while the magnetic tape engaged between the capstan **9** and the pinch roller **10** is fed by the driving force of the capstan motor M2, the interface **1** receiving the input signal Vi such as the compressed HDTV signal or the normal TV signal applies its output V1 to the frame extracting unit **20**. Thereafter, the recorded data is buffered and amplified in the buffer **22** for a predetermined period while the I-frame data is stored in the frame memory **23** in accordance with the write enable signal W/E from the frame detector **24**.

Subsequently, the multiplexer **25** receives selectively the output V**22** from the buffer **22** and the output V**23** from the frame memory **23**, based on the output V**27** from the multiplexing timing generator **27**. As a result, the multiplexer **25** outputs the output signal V**25** as shown in FIG. **10**D to the digital recording unit **18**. Thereafter, the interleaving and channel-dividing circuit **2** of the digital recording unit **18** interleaves the signal V**25** to a predetermined form for reducing burst errors and then outputs signals V2 and V**3** channel-divided to be matched with a recording channel bandwidth to the recording formatters **3**A and **3**B, respectively.

Accordingly, the recording formatters **3**A and **3**B form synchronous blocks shown in FIG. **6** so as to add synchronous signals SYNC, identification signals ID and error correction codes ECC. The recording formatters **3**A and **3**B also form position information blocks of recording tracks, based on the output V**29** from the frame position recorder **29** in the frame position information recording unit **19**, thereby forming position information about the first synchronous blocks of the tracks including I-frames recorded.

Outputs V**4** and V**5** are converted to a predetermined recording format in the channel modulators **4**A and **4**B, amplified to a predetermined level by the recording amplifiers **5**A and **5**B, and then selectively sent to the heads HD1 (or HD3) and HD2 (or HD4) via the switches SW1 and SW2 switched by the output SWP of the drum pulse generator **7** generated by the rotation of the drum motor M**1**.

Thus, the outputs of the recording amplifiers **5**A and **5**B selectively applied to the heads HD1 (or HD3) and HD2 (or HD4) via the switches SW1 and SW2 being switched are recorded on the magnetic tape in a recording format shown in FIG. **9**.

On the other hand, when a speed-varied reproduction mode is selected in a case where the data of the recording format shown in FIG. **9** has been recorded on the magnetic tape, the data recorded on the magnetic tape is reproduced in the digital reproduction unit **32**. That is, signals recorded on the magnetic tape are detected by the heads HD1 (or HD3) and HD2 (or HD4) while the magnetic tape engaged between the capstan **9** and the pinch roller **10** rotated by the capstan motor M**2** travels on the head drum **6** driven by the drum motor M**1**.

The signals detected by the heads HD1 (or HD3) and HD2 (or HD4) are sent to the reproduction amplifiers **11**A and **11**B via the switches SW3 and SW4 switched by the output SWP of the drum pulse generator **7**, respectively. The signals received in the reproduction amplifiers **11**A and **11**B are amplified to a predetermined level and then sent to the equalizers **12**A and **12**B which, in turn, compensate distortions of frequency characteristics of the amplified signals V**10** and V**11**, respectively. Resultant signals V**12** and V**13** from the equalizers **12**A and **12**B are then applied to the channel demodulators **13**A and **13**B which, in turn, demodulate the output signals V**12** and V**13** to the original signal forms, respectively.

Output signals V**14** and V**15** from the channel demodulators **13**A and **13**B are received in the sync-detecting and error-correcting circuits **14**A and **14**B which, in turn, detect respectively synchronous signals SYNC and identification signals ID from the received signals V**14** and V**15** and remove error components included in the recorded data. Resultant signals V**16** and V**17** from the sync-detecting and error-correcting circuits **14**A and **14**B are applied to the deinterleaving circuit **15**A and **15**B which, in turn, deinterleave the signals V**16** and V**17** to the original signal forms, respectively. Resultant signals V**18** and V**19** are then sent to the deformatter **16** of the frame removing unit **35**.

At this time, the frame position information detecting unit **33** detects index information recorded on a control track disposed at the lower edge of the magnetic tape by the index head **31**. The index information is a pulse indicative of a track including an I-frame. On the other hand, the recording position-synchronized block detector **40** detects recording position-synchronized blocks recorded with I-frames from the outputs V**16** and V**17** of the sync-detecting and error-correcting circuits **14**A and **14**B. Upon detecting the index information in order to achieve a discrimination for the position of a specific track, the index signal detector **36** takes into consideration the time taken to control a speed matched with a speed multiple and calculated in the capstan servo speed calculator **38** of the tape speed controlling unit **34**. The physical position of the index head **31** is determined by the processing speed of the capstan servo speed calculator **38**.

The recording position-synchronized block detector **40** also detects the outputs V**16** and V**17** of the sync-detecting and error-correcting circuits **14**A and **14**B and separates recording position-synchronized blocks shown in FIG. **11** from the detected signals V**15** and V**17**. The recording position-synchronized block detector **40** outputs a signal **[40]** *V40* which is indicative of codes relating to the speed multiple and selected from codes indicative of relative positions and present in the separated synchronous blocks. The recording position decoder **39** decodes the signal V**40** received from the recording position-synchronized block detector **40** **[**and**]** *based on* the speed multiple n. An optional code DIFi present in each synchronous block is a code indicative of the number of tracks present between the current track and the i-th track including specific data recorded.

Accordingly, the frame position information detecting unit **33** detects specific track position information periodically or non-periodically recorded and track position information about I-frames recorded in the recording position-synchronized blocks, taking into consideration the calculation time taken to control the speed of the capstan motor M**2** and the driving time. In this connection, the capstan servo speed calculator **38** receives the position information V**36** from the index signal detector **36** and the position information V**39** from the recording position decoder **39** and thereby calculates the rotation speed of the capstan motor M**2** in accordance with the input speed multiple n. Resultant signal V**38** from the capstan servo speed calculator **38** is then applied to the capstan servo driving signal generator **37** which, in turn, controls the speed of the capstan motor M**2** so that the capstan motor M**2** can be driven repeatedly at a normal speed and a high speed. As a result, the heads HD1 to HD4 mounted on the drum **6** repeatedly travel at the normal speed on specific tracks of the magnetic tape and jump travel on other tracks, thereby enabling reproduction of speed-varied videos.

FIGS. **13**A to **13**C illustrate an example of a capstan servo speed control in a case where speed-varied specific data have been recorded on every two-track at intervals of four tracks. In this case, the capstan motor M**2** is driven two tracks at a normal speed in the same direction as the recording tracks for the first half of the initial cycle shown in FIG. **13**B. For the next half of the initial cycle, the capstan motor M**2** is driven four tracks at a high speed. During the accelerated driving, the capstan motor M**2** exhibits the driving characteristic shown in FIG. **13**A because the output V**37** of the capstan servo driving signal generator **37** is periodically varied in level, as shown in FIG. **13**C. By virtue

of such a speed-varied driving of the capstan motor M2, it is possible to reduce an excessive characteristic of the capstan servo speed.

The outputs V18 and V19 from the digital reproduction unit 32 resulted from the speed-varied reproduction are sent to the deformatter 16 of the frame removing unit 35, converted into the signal form prior to the recording, and then outputted as a speed-varied reproduced signal Vo such as a digital HDTV signal or a normal TV signal via the interface 17.

For the signal conversion in the deformatter 16, it is required to remove the stuffing bits or dummy bits added for preventing the underflow phenomenon of the frame memory 23 upon recording data for varied speed on specific tracks. To this end, the stuffing bit-detecting and removing circuit 42 supplies a bit removing signal V42 for preventing any bit string from being outputted to the interface 17 when a stuffing synchronous code recorded at the starting portion of stuffing bits is detected. The supplying of the bit removing signal V42 is continued until a stuffing bit end code is detected.

In the reproduction at the normal speed, the frame removing unit 35 also separates data of recording tracks for varied speed so that the I-frame data recorded on the magnetic tape for the speed-varied reproduction is prevented from being outputted to the interface 17 and thereby being included in the reproduced signal Vo.

On the other hand, the frame removal timing generator 41 receives position information of tracks recorded with specific data for varied speed from both the recording position decoder 39 and the index signal detector 36 of the frame position information detecting unit 33. Based on the output SWP of the drum pulse generator 7 shown in FIG. 14A, the frame removal timing generator 41 then outputs a frame removing signal V41 shown in FIG. 14C to the deformatter 16.

Based on the frame removing signal V41, the deformatter 16 removes I-frame data from the signals V15 and V19 (FIG. 14B) received from the deinterleaving circuits 15A and 15B of the digital reproduction unit 32. As a result, the deformatter 16 outputs a signal V20 shown in FIG. 14D, thereby enabling the reproduction at the normal speed.

As apparent from the above description, the present invention provides an apparatus for controlling recording and reproduction in a magnetic VCR capable of separating specific data for a speed-varied reproduction from compressed digital video signals and recording them on designated tracks in a recording mode, recording position information of the designated tracks on a control track by an index head or recording position information of recording position-synchronized blocks at the starting portions of the designated tracks recorded with the specific data so as to accurately scan the designated tracks in a reproduction mode, controlling a capstan servo speed so as to maintain the travel of a magnetic tape at a normal speed and periodically or non-periodically accelerate or decelerate it where specific data for varied-speed have been recorded periodically or non-periodically on predetermined portions of tracks, thereby making heads travel repeatedly at the normal speed and the high speed and thereby detect continuously the specific tracks for varied-speed. In accordance with the apparatus, the specific data for a speed-varied reproduction is removed in the reproduction at the normal speed. Thus, the reproduction at the normal speed can be accomplished.

Accordingly, the present invention provides a repeatability of reproduced video at a varied speed without any deterioration in picture quality in that it enables recording of specific data for speed-varied reproduction and continuous detection of the specific data in the speed-varied reproduction.

Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

What is claimed is:

1. An apparatus for controlling recording and reproducing in a video cassette tape recorder comprising:

frame extracting means for buffering compressed digital data input thereto, and extracting specific data for a speed-varied reproduction from said compressed digital data;

frame recording position controlling means for calculating a number of tracks for recording the compressed digital data and selectively outputting a buffered output, said extracted specific data from said frame extracting means, and a multiplexing timing signal;

frame position information recording means for recording position information of specific tracks for the speed-varied reproduction and index information on a magnetic tape, based on said multiplexing timing signal;

digital recording means for recording digital signals including said digital data and said index information on said magnetic tape;

digital reproduction means for reproducing the digital signals recorded on the magnetic tape;

frame position information detecting means for detecting said position information of the specific tracks for the speed-varied reproducing and said index information;

tape speed controlling means for controlling the speed of a capstan motor, based on said detected index information and said position information of the specific tracks; and

frame removing means for receiving an output from the digital reproduction means and removing unnecessary bit streams from the specific data.

2. An apparatus in accordance with claim 1, wherein said frame extracting means comprises:

an interface for receiving said compressed digital data;

a buffer for buffering an output of said interface for a predetermined period;

a frame detector for detecting said specific data from said output of the interface and outputting a write enable signal; and

a frame memory for selecting and storing the detected specific data, based on said write enable signal.

3. An apparatus in accordance with claim 2, wherein said frame detector counts a number of frames when a frame mark code is detected from a bit stream of said output of the interface, and enables said write enable signal when said counted number of frames is determined to be the same as an interval number at which I-frames are present.

4. An apparatus in accordance with claim 1, wherein said frame recording position controlling means comprises:

a track number calculator for calculating an average bit rate of said compressed digital data, the size of the specific data, a number of tracks for recording said specific data and a number of tracks present between said specific tracks;

a multiplexing timing generator for receiving an output from said track number calculator and outputting a

switching signal for positioning the specific data on said specific tracks in accordance with a head switching signal;

a multiplexer for selecting an output from said frame extracting means, based on an output from said multiplexing timing generator and sending said selected output to said digital recording means; and

a bit stuffing circuit for filling insufficient data with bit streams or dummy bits when said selected output of the frame extracting means is at an underflow state.

5. An apparatus in accordance with claim **1**, wherein said frame position information recording means comprises:

a frame position recorder for receiving an output from said frame recording position controlling means and outputting position discrimination information to said digital recording means so as to record position information of a next specific track on an initial synchronous block of a track having said specific data recorded thereon; and

an index signal recorder for recording position information of said track having said specific data recorded thereon on a control track of said magnetic tape by an index head.

6. An apparatus in accordance with claim **1**, wherein said frame position information detecting means comprises:

an index signal detector for detecting index information recorded on a control track of said magnetic tape, said index information indicating whether tracks recorded with said specific data are present;

a recording position-synchronized block detector for detecting an output from said digital reproduction means and detecting recording position-synchronized blocks recorded with codes indicative of relative position information of said tracks recorded with said specific data; and

a recording position decoder for decoding an output of said recording position-synchronized block detector, based on a number of different tape speeds, and thereby outputting a signal for calculating a capstan servo speed.

7. An apparatus in accordance with claim **1**, wherein said tape speed controlling means comprises:

a capstan servo speed calculator for calculating a capstan servo speed for repeating a normal speed travel on said specific tracks and a high speed travel on tracks between adjacent specific tracks in a speed-varied reproduction by using the position information of the specific track from said frame position information detecting means based on a number of different tape speeds; and

a capstan servo drive signal generator for controlling driving of said capstan motor, based on an output of said capstan servo speed calculator.

8. An apparatus in accordance with claim **1**, wherein said frame removing means comprises:

a deformatter for converting an output of said digital reproduction means to a signal form prior to recording;

a stuffing bit-detecting and removing circuit for outputting a bit removing signal to said deformatter and removing stuffing bits or dummy bits added for preventing generation of an underflow of said frame extracting means in the speed-varied reproduction; and

a frame removal timing generator for receiving said position information of the specific tracks from said frame position information detecting means and outputting a frame removing signal to the deformatter, based on a head switching signal, thereby preventing outputting of said specific data in a normal-speed reproduction.

9. An apparatus in accordance with claim **1**, wherein said specific data includes I-frames.

10. An apparatus in accordance with claim **1**, wherein said digital recording means and said digital reproduction means include a plurality of heads and switches for selectively recording and reproducing the digital signals.

11. An apparatus for controlling recording in a video cassette tape recorder comprising:

frame extracting means for receiving compressed digital data input thereto and extracting specific data for a speed-varied reproduction from said compressed digital data;

frame recording position controlling means for generating a multiplexing timing signal and multiplexing said compressed digital data and said extracted specific data from said frame extracting means based on said multiplexing timing signal;

frame position information recording means for recording index information and position information of specific tracks for recording said specific data for the speed-varied reproduction on a magnetic tape based on said multiplexing timing signal; and

digital recording means for recording digital signals including said digital data and specific data from said frame recording position controlling means on the magnetic tape.

12. An apparatus in accordance with claim **11**, wherein said frame extracting means includes:

an interface for receiving said compressed digital data;

a buffer for buffering an output of said interface for a predetermined period;

a frame detector for detecting said specific data from said output of the interface and outputting a write enable signal; and

a frame memory for selecting and storing said specific data based on said write enable signal.

13. An apparatus in accordance with claim **12**, wherein said frame detector starts counting frames when a frame mark code is detected from a bit stream of said output of the interface, and enables said write enable signal when said counted frame number equals an interval number at which I-frames are present.

14. An apparatus in accordance with claim **11**, wherein said frame recording position controlling means includes:

a track number calculator for calculating a number of said specific tracks for recording said specific data and a number of tracks present between said specific tracks;

a multiplexing timing generator for generating said multiplexing timing signal based on an output from said track number calculator; and

a multiplexer for selecting an output from said frame extracting means based on said generated multiplexing timing signal.

15. An apparatus in accordance with claim **14**, wherein said frame recording position controlling means includes a bit stuffing circuit for filling insufficient data with bit streams or dummy bits when said selected output of the frame extracting means is at an underflow state.

16. An apparatus in accordance with claim **11**, wherein said frame position information recording means includes:

a frame position recorder for receiving an output from said frame recording position controlling means and

outputting position discrimination information to said digital recording means so as to record said position information of said specific tracks; and

an index signal recorder for recording said index information on a control track of the magnetic tape, said index information including information indicating whether said specific tracks for said specific data are present.

17. An apparatus in accordance with claim **11**, wherein said specific data includes I-frames, and said digital recording means includes a plurality of heads and switches for selectively recording said digital signals.

18. An apparatus in accordance with claim **11**, wherein said digital recording means includes an interleaving and channel driving circuit, a plurality recording formatters, and a plurality of channel modulators, for formatting said digital signals so as to record said digital signals on the magnetic tape.

19. A method for controlling recording and reproduction in a video cassette tape recorder, comprising the steps of:

extracting specific data for a speed varied reproduction from compressed digital data;

calculating a number of tracks for recording said digital data and outputting a multiplexing timing signal based on said calculated number of tracks;

recording position information of specific tracks for the speed varied reproduction and index information on a magnetic tape based on said multiplexing timing signal;

recording digital signals including said digital data and said index information on the magnetic tape;

reproducing said digital signals recorded on the magnetic tape;

detecting said position information of the specific tracks for the speed varied reproduction and said index information;

controlling the speed of a capstan motor based on said detected index information and position information of the specific tracks; and

removing unnecessary bit streams from said specific data.

20. A method in accordance with claim **19**, wherein said specific data includes I-frames.

21. A method of controlling recording in a video cassette tape recorder, comprising the steps of:

extracting specific data for a speed-varied reproduction from compressed digital data;

generating a multiplexing timing signal and multiplexing said compressed digital data and said extracted specific data based on said multiplexing timing signal;

recording index information and position information of specific tracks for recording said specific data for the speed-varied reproduction on a magnetic tape based on said multiplexing timing signal; and

recording digital signals including said multiplexed digital data and specific data on the magnetic tape.

22. A method in accordance with claim **21**, wherein said generating step includes calculating a number of tracks for recording said digital data and generating said multiplexing timing signal based on said calculated number of tracks.

23. An apparatus for controlling recording in a digital video recording device, comprising:

an input unit receiving digital video data, the digital video data including I-frames of intra-coded digital picture data;

a data generating circuit generating a plurality of relative position data, each of the plurality of relative position data associated with one of a plurality of specific data in the received digital video data, wherein the specific data includes the intra-coded digital picture data, and wherein each of the plurality of relative position data is indicative of a plurality of relative positions from a current nth specific data location on a digital recording medium to each of a n+1, n+2, . . . , n+m specific data location on the digital recording medium, where m is greater than 2; and

a recording unit coupled to the data generating circuit and recording the digital video data and the plurality of relative position data on the digital recording medium such that each specific data includes the associated relative position data, as well as the intra-coded digital picture data.

24. The apparatus of claim 23, further comprising:

a detection circuit coupled to the input unit and detecting the specific data from the received digital video data; and wherein

the data generating circuit is coupled to the detection circuit.

25. The apparatus of claim 24, wherein the data generating circuit includes:

a timing signal generating circuit generating a timing control signal; and

a multiplexer coupled to the timing signal generating circuit and selectively outputting the detected specific data and the digital video data based on the timing control signal.

26. The apparatus of claim 23, wherein the digital medium includes a magnetic medium.

27. The apparatus of claim 23, wherein each of the plurality of relative position data includes a plurality of distance indicators, each distance indicator indicating a distance between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

28. The apparatus of claim 27, wherein said distance is represented with a number of distance units present between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

29. The apparatus of claim 28, wherein the distance unit is a track on the storage medium.

30. The apparatus of claim 23, wherein the recording unit includes:

a formatting circuit forming a data block associated with each specific data, the data block including the associated relative position data.

31. An apparatus for controlling reproduction in a digital video reproducing device, comprising:

a reproducing unit reproducing digital video data, the digital video data including I-frames of intra-coded digital picture data stored on a digital recording medium, the digital data including a plurality of specific data, each of said plurality of specific data including relative position data and intra-coded digital picture data, each relative position data indicative of a plurality of relative positions from a current nth specific data location on a digital recording medium to each of a n+1, n+2, . . . , n+m specific data location on the digital recording medium, where m is greater than 2;

a detection circuit coupled to the reproducing unit and detecting one of the plurality of relative position data from the reproduced digital video data; and

a control circuit coupled to the detection circuit, receiving a command and controlling the reproducing unit to reproduce at least another specific data based on the detected relative position data and the command.

32. The apparatus of claim 31, wherein the detection circuit includes:

a decoding circuit selecting one of the relative positions represented in said detected relative position data based on the command.

33. The apparatus of claim 31, wherein each of the plurality of relative position data includes a plurality of distance indicators, each distance indicator indicating a distance between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

34. The apparatus of claim 33, wherein said distance is represented with a number of distance units present between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

35. The apparatus of claim 34, wherein the distance unit is a track on the digital medium.

36. The apparatus of claim 31, wherein the reproducing unit includes a motor for moving the digital medium.

37. The apparatus of claim 36, wherein the control circuit includes:

a calculating circuit calculating a rotational speed of the motor based on the detected relative position data.

38. The apparatus of claim 31, wherein the reproducing unit includes reading heads and signal processing circuits.

39. A method for controlling recording in a digital video recording device, comprising the steps of:

receiving digital video data, the digital video data including I-frames of intra-coded digital picture data;

generating a plurality of relative position data, each of the plurality of relative position data associated with one of a plurality of specific data in the received digital video data, wherein the specific data includes the intra-coded digital picture data, and wherein each of the plurality of relative position data is indicative of a plurality of relative positions from a current nth specific data location on a digital recording medium to each of a n+1, n+2, . . . , n+m specific data location on the digital recording medium, where m is greater than 2; and

recording the digital video data and the plurality of relative position data on the digital medium such that each specific data includes the associated relative position data, as well as the intra-coded digital picture data.

40. The method of claim 39, further comprising the step of:

generating a timing control signal; and

wherein said recording step includes,

recording the digital video data and the specific data based on the timing control signal.

41. The method of claim 39, wherein in said recording step, the digital medium includes a magnetic medium.

42. The method of claim 39, wherein each of the plurality of relative position data includes a plurality of distance indicators, each distance indicator indicating a distance between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

43. The method of claim 42, wherein said distance is represented with a number of distance units present between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

44. The method of claim 43, wherein the distance unit is a track on the digital medium.

45. The method of claim 39, wherein said recording step includes the step of:

forming a data block associated with each specific data, the data block including the associated relative position data.

46. A method for controlling reproduction in a digital video reproducing device, comprising the steps of:

reproducing digital video data, the digital video data including I-frames of intra-coded digital picture data stored on a digital recording medium, the digital video data including a plurality of specific data, each of said plurality of specific data including relative position data and intra-coded digital picture data, each relative position data indicative of a plurality of relative positions from a current nth specific data location on a digital recording medium to each of a n+1, n+2, . . . , n+m specific data location on the digital recording medium, where m is greater than 2;

detecting one of the plurality of relative position data from the reproduced digital video data;

receiving a command; and

reproducing at least another specific data based on the detected relative position data and the command.

47. The method of claim 46, wherein said reproducing step includes the step of:

decoding the detected relative position data by selecting one of the relative positions represented in the detected relative position data based on the command to reproduce the at least another specific data.

48. The method of claim 46, wherein each of the plurality of relative position data includes a plurality of distance indicators, each distance indicator indicating a distance between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

49. The method of claim 48, wherein said distance is represented with a number of distance units present between the current nth specific data location and one of the n+1, n+2, . . . , n+m specific data locations.

50. The method of claim 49, wherein the distance unit is a track on the digital medium.

51. The method of claim 46, wherein said reproducing step includes the step of:

calculating a rotational speed of a motor for moving the digital medium based on the detected relative position data.

52. A digital video recording medium having a data structure for controlling a reproducing operation, comprising:

a plurality of specific data areas, each specific data area storing digital specific data including intra-coded digital picture data and associated relative position data, the associated relative position data indicative of a plurality of relative positions from a current nth specific data location on the digital video recording medium to each of a n+1, n+2, . . . , n+m specific data location on the digital video recording medium, where m is greater than 2.

* * * * *

EXHIBIT D

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(19) **United States**

(12) **Reissued Patent**
Park

(10) **Patent Number: US RE37,052 E**

(45) **Date of Reissued Patent: Feb. 13, 2001**

(54) **COPY PREVENTION METHOD AND APPARATUS OF A DIGITAL RECORDING/REPRODUCING SYSTEM EMPLOYING A MARKER INCLUDING COPY PROTECTION INFORMATION AND CODE DATA FOR DESCRAMBLING**

(75) Inventor: **Tae Joon Park**, Seoul (KR)

(73) Assignee: **LG Electronics, Inc.**, Seoul (KR)

(21) Appl. No.: **09/094,575**

(22) Filed: **Jun. 12, 1998**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **5,689,559**
Issued: **Nov. 18, 1997**
Appl. No.: **08/566,000**
Filed: **Dec. 1, 1995**

(30) **Foreign Application Priority Data**

Dec. 8, 1994 (KR) 94-33336

(51) **Int. Cl.**[7] **H04N 7/167**; G11B 15/05

(52) **U.S. Cl.** **380/203**; 380/239; 360/60; 705/57; 386/94

(58) **Field of Search** 380/3, 4, 5, 20, 380/22, 203, 239; 386/94; 360/60; 705/57

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,694,489	*	9/1987	Frederiksen	380/10
4,890,319	*	12/1989	Seth-Smith et al.	380/5
5,057,947	*	10/1991	Shimada	360/60
5,231,546	*	7/1993	Shimada	360/60
5,418,853	*	5/1995	Kanota et al.	380/5
5,575,787	*	11/1996	Ryan	380/5
5,579,120		11/1996	Oguro	386/94
5,588,058		12/1996	Le Berre	380/228
5,659,613		8/1997	Copeland et al.	380/202
5,673,357	*	9/1997	Shima	386/94
5,799,081	*	8/1998	Kim et al.	380/5
5,907,443	*	5/1999	Hirata	380/4 X

* cited by examiner

Primary Examiner—Pinchus M. Laufer

(57) **ABSTRACT**

[A copy prevention method and apparatus of a digital magnetic recording/reproducing system performs the copy prevention function by encoding to insert a marker involving copy prevention function information and executing the function and allows a program supplier to realize a desired copy prevention function of various patterns, in which the marker formed by a control word for scrambling audio and video bit straps and copy prevention information for preventing an illegal copy is encrypted by an encoded key to be multiplexed with the audio and video bit strips scrambled by the control word. The marker transmitted is detected from the bit strips to be decrypted and analyzed by the encoded key to determine whether the copy is permitted or not, so that the detected marker is updated to be recorded on a video tape and the control word is produced from the marker to perform the descrambling to supply the result to a monitor to be displayed. Thus, the program supplier selects the copy prevention function, and a separate format converting apparatus is not required since a field defined within a GA format is utilized while an existing DVCR is not need to be changed for performing the copy prevention function as the data amount to be recorded is not increased.] *The method and apparatus for transmitting and/or recording digital data generates control data and initializes a scrambler based on the control data. Digital data is scrambled using the scrambler. A marker is formed including the control data and the scrambled digital data and the marker are transmitted or recorded as a packet. The packet includes a header, which includes the marker. When the scrambled digital data and the marker, as a packet, are received, the marker is detected and the control data is obtained from the marker. A descrambler is initialized based on the control data, and the scrambled digital data is descrambled using the descrambler.*

88 Claims, 5 Drawing Sheets

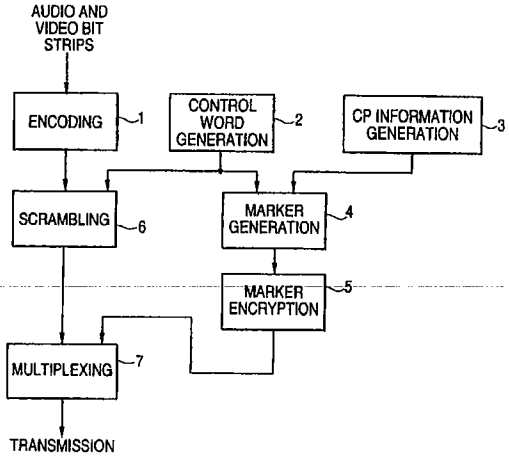


FIG. 1

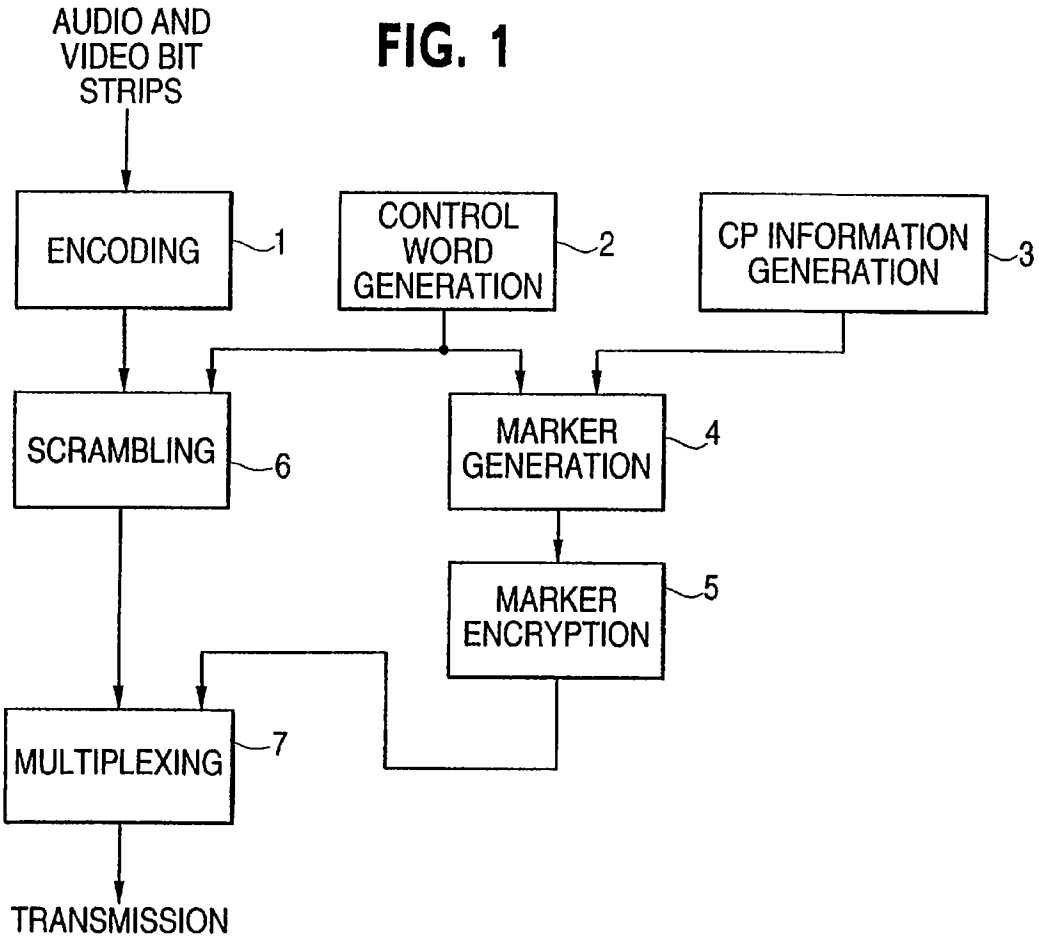

AUDIO AND VIDEO BIT STRIPS
ENCODING
1
CONTROL WORD GENERATION
2
CP INFORMATION GENERATION
3
SCRAMBLING
6
MARKER GENERATION
4
MARKER ENCRYPTION
5
MULTIPLEXING
7
TRANSMISSION

FIG. 2

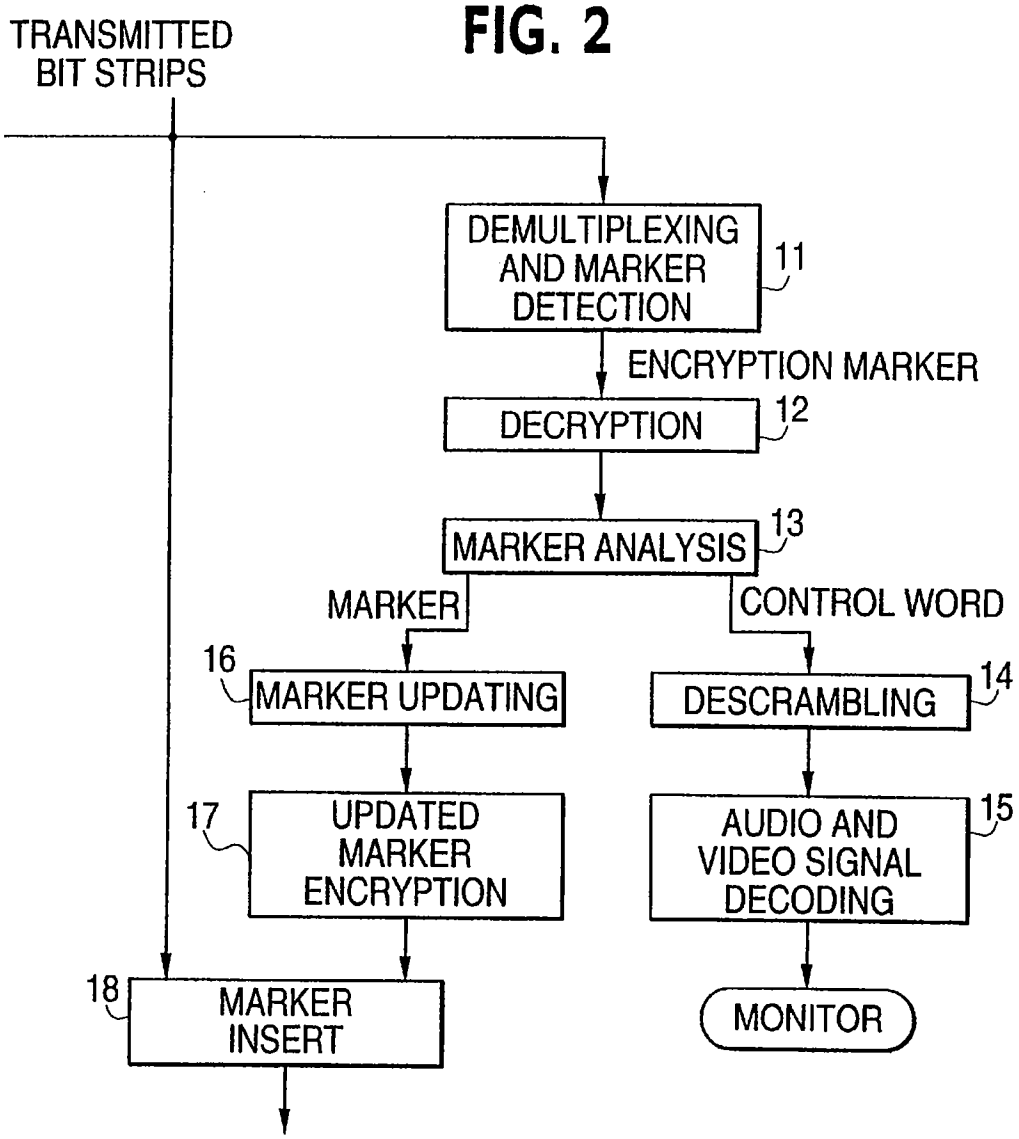

TRANSMITTED BIT STRIPS
DEMULTIPLEXING AND MARKER DETECTION
11
ENCRYPTION MARKER
DECRYPTION
12
MARKER ANALYSIS
13
MARKER
CONTROL WORD
16
MARKER UPDATING
DESCRAMBLING
14
17
UPDATED MARKER ENCRYPTION
AUDIO AND VIDEO SIGNAL DECODING
15
18
MARKER INSERT
MONITOR

FIG. 3

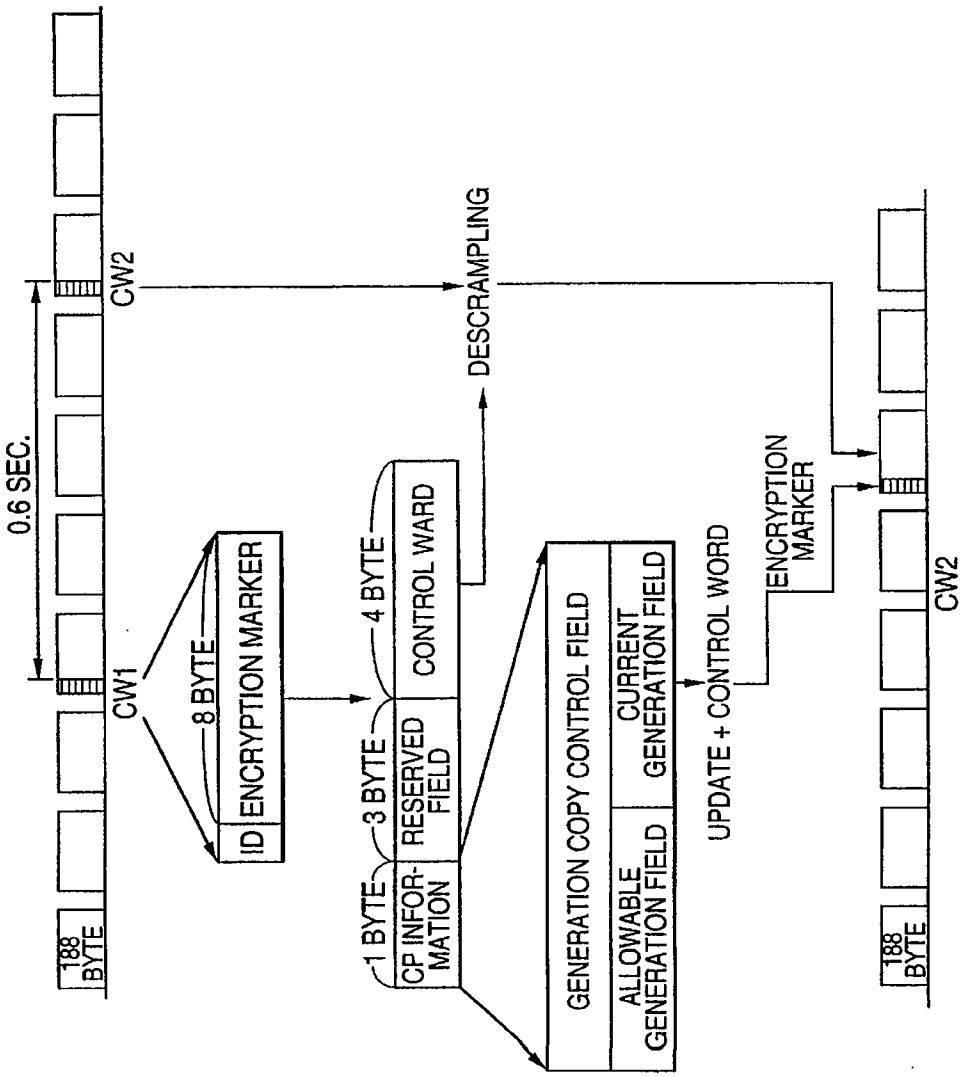

188 BYTE
0.6 SEC.
CW1
CW2
8 BYTE
ID
ENCRYPTION MARKER
4 BYTE
CONTROL WARD
3 BYTE
RESERVED FIELD
1 BYTE
CP INFOR-MATION
DESCRAMPLING
GENERATION COPY CONTROL FIELD
ALLOWABLE GENERATION FIELD
CURRENT GENERATION FIELD
UPDATE + CONTROL WORD
ENCRYPTION MARKER
CW2
188 BYTE

FIG. 4

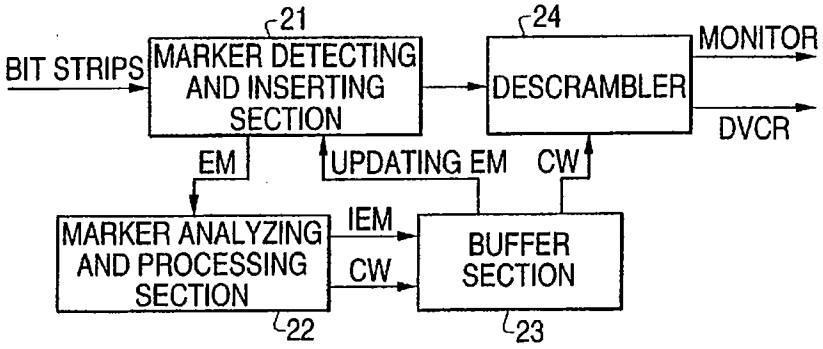
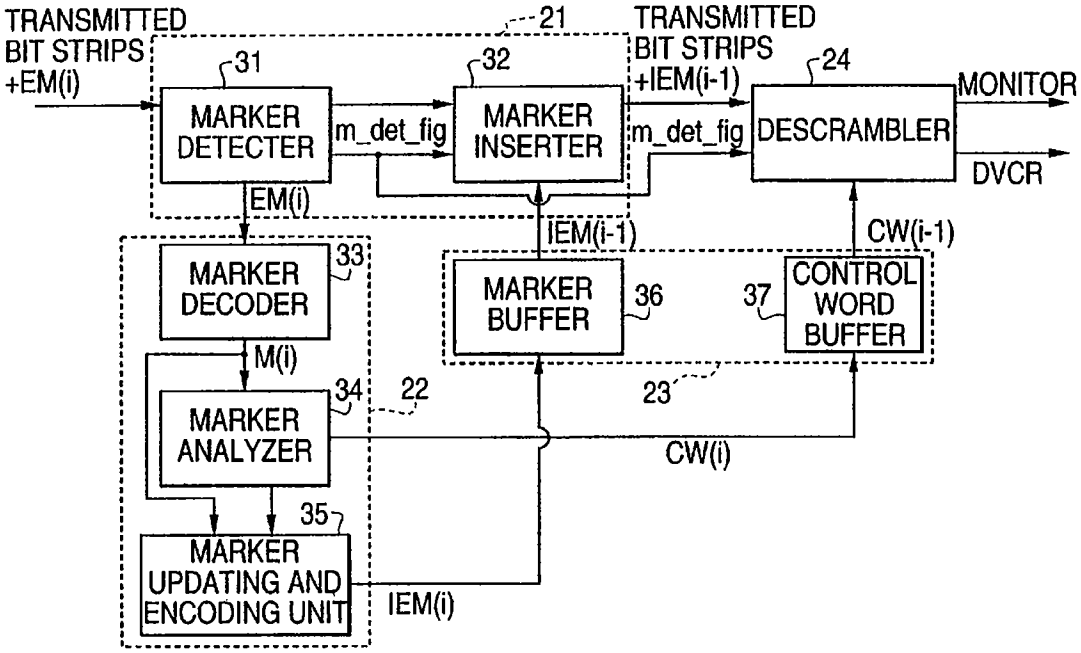

21
24
BIT STRIPS
MARKER DETECTING AND INSERTING SECTION
DESCRAMBLER
MONITOR
DVCR
EM
UPDATING EM
CW
IEM
CW
MARKER ANALYZING AND PROCESSING SECTION
BUFFER SECTION
22
23

FIG. 5


TRANSMITTED BIT STRIPS +EM(i)
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31
32
24
MONITOR
MARKER DETECTER
m_det_fig
MARKER INSERTER
m_det_fig
DESCRAMBLER
DVCR
EM(i)
IEM(i-1)
CW(i-1)
33
MARKER DECODER
MARKER BUFFER
36
37
CONTROL WORD BUFFER
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IEM(i)

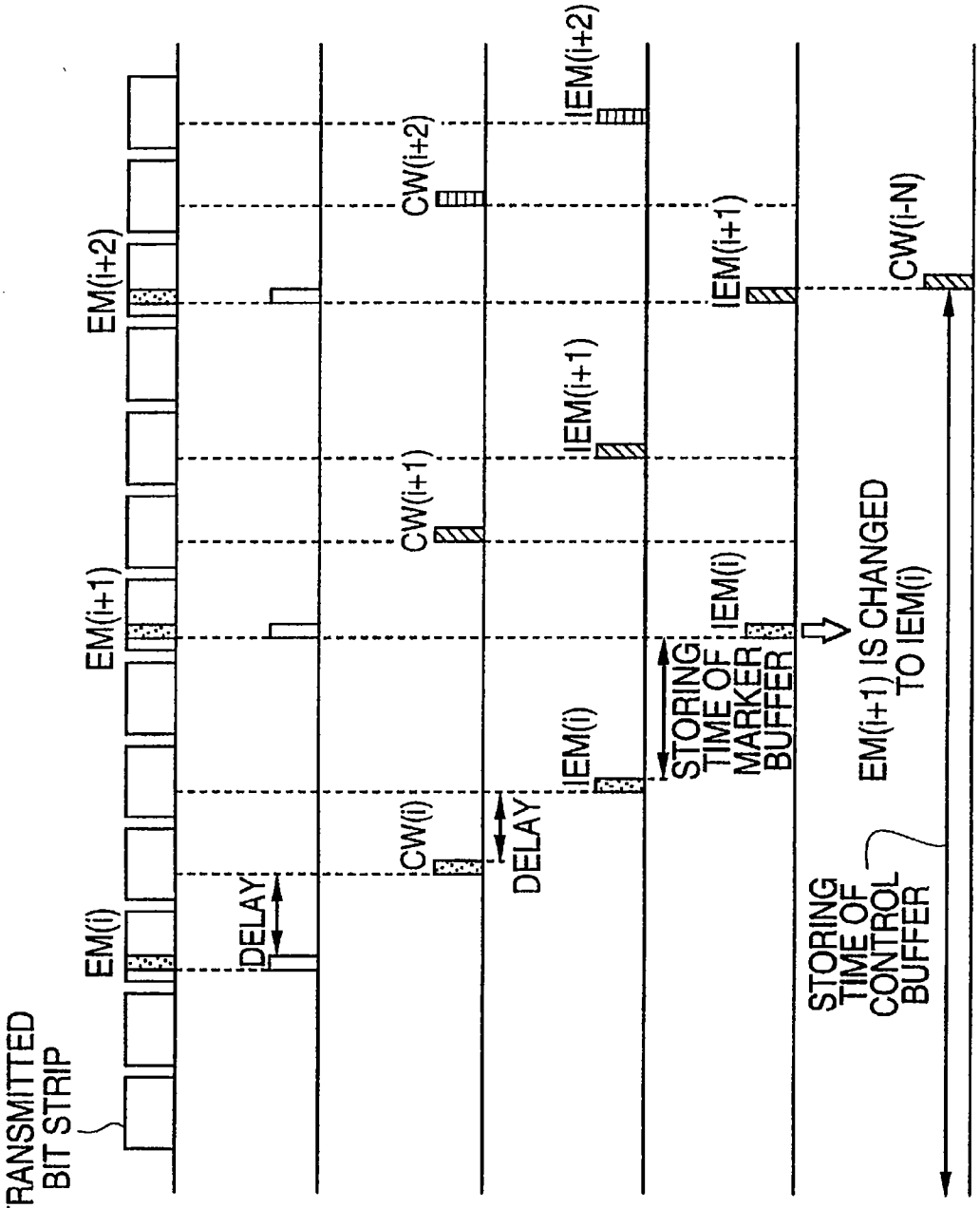

FIG. 6A FIG. 6B FIG. 6C FIG. 6D FIG. 6E FIG. 6F

COPY PREVENTION METHOD AND APPARATUS OF A DIGITAL RECORDING/REPRODUCING SYSTEM EMPLOYING A MARKER INCLUDING COPY PROTECTION INFORMATION AND CODE DATA FOR DESCRAMBLING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED APPLICATION

This reissue application is related to concurrently filed reissue application No. 09/097,667, which is a divisional of the subject reissue application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a copy prevention method and apparatus of a digital [magnetic] recording/reproducing system, and more particularly to a copy prevention method and apparatus of a digital [magnetic] recording/reproducing system, wherein a marker involving copy prevention function information and executing the function is coded and inserted to perform the copy prevention function and realize the copy prevention function of various patterns desired by a program supplier.

2. Description of the Prior Art

One example of a conventional copy prevention method is described in U.S. Pat. No. 4,819,098, in which a signal inducing an interference to an automatic gain controller (AGC) circuit within a VCR is inserted to a video waveform to be recorded on a tape. When the tape is reproduced to display the signal on a television, the interference signal does not affect the AGC circuit of the television [to allow], *allowing* for a normal display.

However, when the reproduced signal is recorded by another VCR, i.e., when it is duplicated, the interference signal brings about [the] interference in the AGC circuit of the *recording* VCR [to record in] *causing* an inaccurate signal level *to be recorded*. Accordingly, the nodal display cannot be attained when reproducing a duplicated tape.

As another example, U.S. Pat. No. 4,571,642 utilizes a control track employed during performing the reproduction for synchronizing a servo circuit within a VCR, [thereby] *for* embodying the copy prevention function. The basic concept of this patent is for altering a video signal to force the control track to be inaccurately recorded when the video signal is duplicated onto another tape.

Still another example is disclosed in U.S. Pat. No. 4,577,216, in which a phase noise or the like is inserted [to] *in* a chroma burst portion of a video signal to thereby embody the copy prevention function.

The above-mentioned methods [are for using] *using* a difference [of] *between the* sensitivity [between] *of* circuits [of] *in* a television and [of] a VCR. [Thus, the copy prepared to prevent the copy thereof as above may not exert the copy prevention function in a certain VCR, but may not execute a normal display on a certain television.]

The above copy prevention methods are of an analog system, which are available for preventing the copy of an NTSC-class video signal to an analog VCR. However, in case of a high-definition image of the analog television (ATV), the copy is performed by means of a digital VCR rather than an analog VCR, so that it is difficult to employ the copy prevention method of the analog system.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a copy prevention method and apparatus of a digital [magnetic] recording/reproducing system [applicable] to a digital VCR and incorporated with various copy prevention functions to enable the selection of a copy prevention function desired by a program supplier.

To achieve the above object of the present invention, there is provided a copy prevention method of a digital magnetic recording/reproducing system, which is performed by an audio and video signal transmitting process and an audio and video signal receiving/recording process. The audio and video signal transmitted process is carried out in the sequence of encrypting a marker formed by a control word for scrambling audio and video bit strips and copy prevention information for preventing an illegal copy by means of an encoding key, and multiplexing the marker with the audio and video bit strips scrambled by the control word. Then, the audio and video signal receiving/recording process is performed in the sequence of detecting the marker from the transmitted bit strips, decrypting and analyzing the detected marker by means of an encoded key to determine whether [copy] *copying* is permitted or not, updating the detected marker to be recorded on a video tape, and generating the control word from the marker to perform a descrambling and supply the audio and video signals to be displayed on a monitor.

Also, a copy prevention apparatus of a digital magnetic recording/reproducing system includes a marker detecting and inserting part for detecting a marker from input bit strips, and inserting the updated marker to the bit strips to output the result. A marker analyzing and processing part decrypts and analyzes the encrypted marker from the marker detecting and inserting part by means of an encoded key, outputs a control word for descrambling the bit strips, and updates and encrypting the decrypted marker by means of the encoded key to output the result. In addition, a buffer part buffers the control word and updated and encrypted marker from the marker analyzing and processing section, and inserts the updated and encrypted marker in the marker detecting and inserting part, and a descrambler descrambles the bit strips provided via the marker detecting and inserting part by means of the control word from the buffer part.

These and other objects are achieved by providing a method of copy protecting digital data, comprising generating copy prevention information; generating control data; scrambling digital data based on said control data; forming a marker, said marker including said copy prevention information and said control data; and transmitting said scrambled digital data and said marker.

These and other objects are further achieved by providing a method of processing copy protected digital data, comprising receiving digital data said digital data including copy prevention information; determining from said copy prevention information whether copying is permitted; updating said copy prevention information if said determining step determines that a copy is permitted; inserting said updated copy prevention information in place of said copy prevention information only in said digital data for recording; and recording output from said inserting step.

These and other objects are still further achieved by providing an apparatus for copy protecting digital data, comprising a copy prevention generator generating copy

prevention information; a control data generator generating control data; a scrambler scrambling digital data based on said control data; marker forming means for forming a marker, said marker including said copy prevention information and said control data; and a transmitting unit transmitting said scrambled digital data and said marker.

In an alternative embodiment, the scrambled digital data and the marker are recorded.

These and other objects are still further achieved by providing an apparatus for processing copy protected digital data, comprising a receiving unit receiving digital data, said digital data including copy prevention information; an analyzing unit determining from said copy prevention information whether copying is permitted, and updating said copy prevention information if a copy is permitted; an inserting unit inserting said updated copy prevention information in place of said copy prevention information only in said digital data for recording; and a recording unit recording output from said inserting unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and other advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. **1** is a flow chart illustrating an audio and video signal transmitting process in a copy prevention method according to the present invention;

FIG. **2** is a flow chart illustrating an audio and video signal receiving and recording process in the copy prevention method according to the present invention;

FIG. **3** is a view showing a structure of transport bit strips according to the present invention;

FIG. **4** is a block diagram showing a schematic construction of a copy prevention apparatus according to the present invention;

FIG. **5** is a block diagram showing a detailed construction of FIG. **4**; and

FIGS. **6**A to **6**F are signal waveforms of respective parts shown in FIG. **5**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A copy prevention method and apparatus of a digital [magnetic] recording/reproducing system according to the present invention [emphasizes a fact that a DVCR can record all diverse signals on a video tape, so that a variety of input signals are largely classified into two, and different] *use a* copy prevention [methods are performed for each signal] *method based on the type of input signal.*

First, signals transmitted from a terrestrial broadcasting *system*, a satellite broadcasting *system* and a pay television broadcasting *system* are classified as [a] broadcasting [signal] *signals*, and the following three copy prevention functions are applicable when recording [the] *a* broadcasting signal.

[Three] *The three* copy prevention functions are a no recording [onto a video tape] *permitted*, a free record/copy [onto the tape], and a single generational recording [onto the tape with no copy of the recorded tape].

Here, the third *copy prevention* function [of the single generational recording onto the video tape with no duplication of the recorded tape] is for enabling the signal from a television receiver to [record on the tape] *be recorded* once

but [inhibiting] the re-recording of the signal by means of [another], *for example, a* DVCR *is prohibited* while the firstly-recorded [tape] *signal* can be reproduced to watch through a monitor.

A second classification is for, *for example,* a rental tape to be identified by a pretaped signal. Here, the copy prevention function of the pretaped signal is similar to the above no recording [onto the tape]and the free record/copy [onto the tape] *copy protection function,* [which] *and* has the following three *copy protection* functions.

The three functions are no copy onto another tape, free copy to another tape and a single generational copy to another tape.

The single generational copy function [to the other tape is of the copy prevention function for allowing a] *allows* duplication from the original [rental tape], but [inhibiting] *inhibits* another copy from the [duplication, which is utilized in a digital audio tape (DAT)] *duplicate.*

The present invention is advantageous in that a program supplier selects the above functions when providing a program. For this purpose, the program supplier inserts desired copy prevention function information, i.e., a marker, into a predetermined field within the program.

The marker inserted [to transport data] by the program supplier prior to being transmitted is encoded, and, in order to impede an illegal copy, an encoding key for interpreting the marker is transferred via a separate transmission line such as telephone line by a prescribed period interval, e.g., once a month, to be stored within a copy prevention apparatus.

In a system having an ATV decoder incorporated *in a body* with, *for example,* the DVCR [in a body], a copy prevention apparatus for embodying the copy prevention functions executes a digital copy prevention function during an interface process between the ATV decoder and *the* DVCR[, and] . *The copy prevention apparatus* decodes and determines the marker of a received program by means of a received [encoded] *encoding* key to perform another function in accordance with respective copy prevention functions.

The copy prevention method of the digital [magnetic] recording/reproducing system according to the present invention is performed through an audio and video signal transmitting process as shown in FIG. **1**, and an audio and video signal receiving and recording process as shown in FIG. **2**.

The audio and video signal transmitting process is for encrypting the marker formed by a control word for scrambling audio and video bit strips and copy prevention (hereinafter simply referred to as "CP") information for preventing an illegal duplication by means of an encoded key to multiplex and transmit the audio and video bit strips scrambled by the control word. Here, the marker is already formed by a program producer to be multiplexed and transmitted together with the audio and video bit strips.

In more detail, as shown in FIG. **1**, the audio and video signal transmitting process is carried out in the sequence of an audio/video bitstrip encoding step **1** for encoding the audio and video bit strips, a control word generating step **2** for generating the control word for scrambling, and a scrambling step **6** for scrambling the encoded audio and video bit strips by means of the generated control word. Successively, a CP information generating step **3** generates the CP information for preventing the illegal copy, *and* marker producing and encrypting. steps **4** and **5** [generates] *respectively generate* the marker by using the generated

control word and CP information and [encrypts] *encrypt* the resulting marker by means of [the encoded] *an encoding* key. Finally, a multiplexing and transmitting step **7** multiplexes the scrambled audio and video bit strips and encrypted marker to transmit the result.

The audio and video signal receiving and recording process is performed in such a manner that the marker is detected from the transmitted bit strips and is decrypted by means of the [encoded] *encoding* key and analyzed. Thus, it is determined whether the copy is permitted or not [to update the detected marker to be recorded on a video tape] , *the detected marker is updated accordingly*, and the control word is produced from the marker to carry out the descrambling and display the signals on a monitor[, in which] . *As a result,* the audio and video signals transmitted from the program producer are recorded or displayed in accordance with the marker.

[More specifically, as shown in] FIG. **2**[,] *shows* the audio and video signal receiving and recording process [is performed by] *in detail. As shown, the process includes* marker detecting steps **11** and **12** for detecting the marker by demultiplexing the transmitted bit strips, and decrypting the marker by means of the [encoded] *encoding* key, and a marker analyzing step **13** for analyzing the detected marker to determine whether [the] *a* copy is permitted or not and *for* detecting the control word. Then, the transmitted audio and video bit strips are descrambled and decoded [by] *using* the detected control word to supply the audio and video signals in audio and video decoding steps **14** and **15**. Thereafter, the detected marker is updated and encrypted by means of the [encoded] *encoding* key [to be inserted in case of permitting the copy after analyzing the marker in a] *and inserted in the transmitting audio and video bit strips in* marker inserting steps **16**, **17** and **18** *if copying is permitted.*

The above-stated process will be described in detail below.

To begin with, the program producer encodes the audio and video bit strips **1**, generates the control word for scrambling **2**, and scrambles the encoded audio and video bit strips by means of the generated control word **6**.

Also, the CP information for preventing the illegal copy is generated **3**, [and] the marker is generated by using the generated control word and CP information **4**, and the coded key is utilized to perform the encryption **5**.

Finally, the scrambled audio and video bit strips and encrypted marker are multiplexed **7** to be transmitted for the program recording or reproduction.

The transmitted bit strips are demultiplexed to detect the marker **11**[, and the encoded] . *The encoding* key is utilized to perform the decryption and the decrypted marker is output **12**. The detected and decrypted marker is analyzed to determine whether the copy is permitted or not and the control word is detected **13**.

The detected control word is used for descrambling and decoding the transmitted audio and video bit strips to provide the audio and video signals to the monitor [to be displayed] *for display* **14** and **15**.

In addition, when it is determined that [the] *a* copy is permitted after analyzing the marker, the detected marker is updated [to be encrypted], *re-encrypted* by means of the [encoded] *encoding* key, and the result is inserted to the audio and video bit strips to be recorded **16**, **17** and **18**.

Here, a position of inserting the marker will be observed with reference to FIG. **3**.

The transmitted bit strips [consists] *consist* of transport packets of a fixed length, i.e., 188 bytes, in which a transport header is displaced on the preceding stage of the bit strips. The transport header is divided into a field of a fixed length of 4 bytes and an adaptation field of a variable length. Then, a transport-private-data field exists as one field within the adaption field. The transport-private-data field consists of an ID field and the encrypted marker. The ID field functions as [a] *an* identifier for informing that the transport-private-data field is a field utilized for the copy prevention method according to the present invention, and the encrypted marker following the ID field embodies the copy prevention function of the present invention.

When the marker is decrypted by means of the [encoded] *encoding* key, the decrypted marker is divided into a CP information area [recorded with] *including* the CP information for preventing the illegal copy, a control word area [recorded with] *including* the control word CW for descrambling, and a reserved area.

That is, the decrypted marker is formed of 8 bytes consisting of the CP information area of one byte, the reserved area of three bytes and control word area of four bytes.

At this time, the CP information is formatted by including a generational copy control field which restricts the number of [permitting the copy] *permitted copies* of the program[, which]. *The generational copy control field* is formed of an allowable generational field for limiting the copy number of the program and a current generational field representing a current generation of the duplicated program.

Next, the marker analyzing step **13** of the audio and video receiving and recording process will be described in detail.

The marker analyzing step **13** is carried out by the CP information detecting step of detecting the CP information for preventing the illegal copy from the detected marker, a copy number limiting step of comparing the allowable generation of the allowable generational field for restricting the number of permitting the copy of the program and the current generation of the current generational field representing the current generation of the duplicated program within the detected CP information to determine whether the copy is permitted or not, and the control word detecting step of detecting the control word from the detected marker for executing the descrambling.

In other words, the CP information for preventing [the] *an* illegal copy is detected from the detected marker, and the allowable generation of the allowable generational field for limiting the copy number of the program is compared with the current generation of the current generational field representing the current generation of the duplicated program within the detected CP information to determine whether the copy is permitted or not, so that the program is recorded in case of permitting the copy[, otherwise the]. *Otherwise,* reproduction cannot be executed in case of inhibiting the copy even though the recording is attained.

Next, the control word for descrambling is detected from the detected marker.

Here, the step of limiting the copy number is carried out by comparing the allowable generation of the allowable generational field with the current generation of the current generational field to determine whether the allowable generation is the current generation, inhibiting the copy when it is determined that the allowable generation is below the current generation, and permitting the copy when it is determined that the allowable generation is not below the current generation [to proceed to the marker insertion step].

The copy number limiting step will be described below.

When the allowable generation is below the current generation after comparing the allowable generation of the

allowable generational field preset by the program producer with the current generation of the current generational field representing the current copy number, the copy number exceeds the copy number preset by the program producer. Thus, [the copy cannot be further] *copying cannot be* permitted.

At this time, in order to inhibit the copy, the control word is destructed or is not output [to block the], *which blocks* reproduction [after performing] *of* the copy. This is because the audio and video bit strips are recorded under the state of being scrambled, the scrambled audio and video bit strips cannot be descrambled without the control word.

Therefore, by destructing the control word, the reproduction and display cannot be achieved even though the audio and video bit strips are recorded [to]; thereby [have] *having* the same effect [of] *as* impeding the recording of them.

At this time, since the control word is periodically changed [in the] *of an* interval of 0.6 second, the reproduction is impeded by destructing the succeeding control word even after accomplishing the recording.

Also, a control track within the video tape may be destructed to inhibit the copy *when the recording medium is a video tape.*

On the other hand, the marker is positioned on the private data field within the bit strips whenever the control word is changed.

Here, since the control word is periodically changed, the marker including the control word is received whenever the control word is changed [to be supplied].

Meantime, the marker inserting step is performed by updating the marker when the copy is permitted after analyzing the marker **16**, encrypting the updated marker by means of the encoded key **17**, and replacing the encrypted marker with the [following] marker to be inserted **18**.

In other words, if the copy is permitted after analyzing the marker, the current generation of the current generational field is augmented by one to update the marker **16**. That is, the CP information including the updated current generational field obtained by augmenting the current generation by one is summed with the control word to be the updated marker.

The updated marker is encrypted by means of the [encoded key to be replaced with] *encoding key and is inserted to replace* the succeeding marker and inserted **17**. More specifically, as the marker is supplied whenever the control word is changed, it is inserted whenever the control word is changed.

In other [word] *words*, as shown in FIG. **3**, the detection of the encrypted marker and the replacement of the updated marker should be accomplished altogether on time basis.

Meanwhile, the [encoded] *encoding* key for encrypting and decrypting the marker is transmitted via a separate transmission line in a predetermined time interval and is stored to be utilized, thereby perfectly preventing the illegal copy.

That is, the marker encrypted by the [encoded] *encoding* key is transmitted and recorded together with the bit strips. Here, the control word for descrambling the scrambled audio and video bit strips is included in the marker, so that the marker should be primarily decrypted to obtain the control word. However, since the [encoded] *encoding* key for decrypting the marker is periodically changed, it is impossible to decrypt the marker without the [encoded] *encoding* key. Accordingly, it is further difficult to illegally obtain the control word.

As shown in FIG. **4**, the copy prevention apparatus of the digital magnetic recording/reproducing system according to the present invention includes a marker detecting/inserting section **21**, a descrambler **24**, a marker analyzing/processing section **22** and a buffer section **23**.

Marker detecting/inserting section **21** detects the marker from the received bit strips, and inserts [to output] *the* updated marker, i.e., the updated and encrypted marker, from buffer section **23** to the bit strips.

Marker analyzing/processing section **22** utilizes the [encoded key] *encoding keys* to decrypt and analyze the encrypted marker from marker detecting/inserting section **21**, thereby providing the control word CW for descrambling the bit strips. Then, the decrypted marker is updated and encrypted by the [encoded] *encoding* key [to be] *for* output.

Buffer section **23** buffers control word CW and *the* updated and encrypted marker IEM from marker analyzing/processing section **22**, so that *the* updated and encrypted marker IEM is supplied to be inserted in marker detecting/inserting section **21**.

Descrambler **24** descrambles the bit strips output via marker detecting/inserting section **21** by means of the control word CW from buffer section **23** to supply the result to the monitor to be displayed or to, *for example*, a DVCR to record the bit strips [inserted] with the marker.

Here, the [encoded] *encoding* key is transmitted via the separate transmission line [in] *at* a predetermined time interval and is stored as the copy prevention method of the digital magnetic recording/reproducing system according to the present invention to double a copyright protection effect.

Referring to FIG. **3**, the structure of the transport bit strips and marker will be described prior to describing the operation of the copy prevention apparatus of the digital magnetic recording/reproducing system constructed as above.

In the copy prevention apparatus of the digital magnetic recording/reproducing system, the marker is placed on the transport-private-data field within the bit strips, and the CP information area recorded with the CP information for preventing the illegal copy and the control word area recorded with the control word CW for descrambling are included thereto as shown in FIG. **3**, like the copy prevention method.

Here, the CP information is formatted by including the generational copy control field for restricting the number of permitted copies of the program, which is formed of the allowable generational field for limiting the copy number of the program and the current generational field representing the current generation of the duplicated program.

The marker is formed of 8 bytes consisting of the CP information area of one byte and control word area of four bytes.

Hereinbelow, an operation of the copy prevention apparatus of the digital [magnetic] recording/reproducing system according to the present invention will be briefly described with reference to FIG. **4**.

First, a process of displaying the input bit strips on the monitor will be described.

The input bit strips are supplied to marker analyzing/processing section **22** under the state that the marker is detected and encrypted in marker detecting/inserting section **21**.

Encrypted marker EM is decrypted by means of the [encoded] *encoding* key to be analyzed in marker analyzing/processing section **22**. At this time, the control word is detected from the analyzed marker [to be buffered] via buffer

section **23** for descrambling the bit strips and is supplied to descrambler **24**.

The bit strips, after [detecting] *the detection of* the marker in marker detecting/inserting section **21**, are descrambled in descrambler **24** in accordance with the control word from buffer section **23**, and provided to the monitor [to be displayed] *for display*.

Next, a process of recording the input bit strips via, *for example,* the DVCR will be described.

The process of detecting and analyzing the marker from the input bit strips is executed in the same manner.

That is, the input bit strips [is] *are* supplied to marker analyzing/processing section **22** under the state that the marker is detected and [encrypted] *decrypted* in marker detecting/inserting section **21**.

Encrypted marker EM is decrypted by means of the [encoded] *encoding* key in marker analyzing/processing section **22** to detect the control word. At this time, the recording can be performed or not in accordance with the result of the analysis. If the recording is not permitted, the detected control word is destructed to impede the reproduction even though the recording can be attained. Otherwise, the current generation of the current generational field within the marker is augmented by one to update the marker, [so that] the [encoded] *encoding* key is utilized to encrypt the marker [to supply], *and* the result *is supplied* to buffer section **23**.

The updated and encrypted marker is buffered in buffer section **23** and is supplied to marker detecting/inserting section **21** to be inserted to the input bit strips.

Meantime, the control word is periodically changed in the interval of 0.6 second, and the marker is placed on the transport-private-data field within the bit strips whenever the control word is changed.

Consequently, the updated and encrypted marker [is replaced with] *replaces* the succeeding marker [to be inserted].

The bit strips [inserted] with the updated and encrypted marker pass through descrambler **24** intact and are output to be recorded in the DVCR.

The detailed construction and operation of the copy prevention apparatus in the digital magnetic recording/reproducing system formed as above will be described with reference to the accompanying drawings.

FIG. **5** is a detailed construction view showing the copy prevention apparatus of FIG. **4**, which will be described below.

Marker detecting/inserting section **21** includes a marker detector **31** which detects the encrypted marker from the input bit strips and supplies the detected marker to marker analyzing/processing section **22** and a marker detection flag signal for informing of the position of the encrypted marker within the bit strips to descrambler **24** [to be]. *The flag is* used as a reference signal [of] *for* initializing descrambler **24** while outputting the bit strips. In addition to marker detector **31**, a marker inserter **32** inserts the updated and encrypted marker from buffer section **23** [to] *into* the bit strips from marker detector **31** in accordance with the marker detection flag signal from marker detector **31** [to output the]. *The* result *is output* to descrambler **24**.

Marker analyzing/processing section **22** has a marker decoder **34** for decrypting the encrypted marker from marker detector **31** of marker detecting/inserting section **21** by means of the [encoded] *encoding* key, and a marker analyzer **34** [for analyzing] *analyzes* the CP information within the marker from marker decoder **34** to output the control word to buffer section **23** when the copy is permitted while outputting a control signal for updating the marker. Additionally, a marker updating/encoding unit **35** updates the marker from marker decoder **34** in accordance with the control signal from marker analyzer **34** to encrypt the marker by means of the [encoded] *encoding* key to output the result to buffer section **23**.

Here, marker analyzing/processing section **22** further includes an encoding key storage unit (not shown) for storing the [encoded] *encoding* key to output the [result] *encoding key* to marker decoder **33** and marker updating/encoding unit **35**.

[Besides] *Also,* marker analyzer **34** compares the allowable generation of the allowable generational field for restricting the number of permitting the copy of the program with the current generation of the current generational field representing the current generation of the duplicated program to determine whether [the] *a* copy is permitted or not.

Buffer section **23** includes a marker buffer **36** for temporally storing the updated and encrypted marker from marker analyzing/processing section **22** to supply it to marker detecting/inserting section **21**, and a control word buffer **37** for temporally storing the control word from marker analyzing/processing section **22** to supply it to descrambler **24**.

An operation of the copy prevention apparatus of the digital magnetic recording system according to the present invention constructed as above will be described with reference to [FIG. **6**] *FIGS. 6A–6G*.

FIG. **6A** is a timing chart of the transmitted bit strips, FIG. **6B** [is of] *illustrates* the marker detection flag m-det-flag, FIG. **6C** [is of] *illustrates* the control word CW(i) from marker analyzer **34**, FIG. **6D** [is of] *illustrates* the updated and encrypted marker IEM(i) from marker updating/encoding unit **35**, FIG. **6F** [is of] *illustrates* the updated and encrypted marker IEM(i) from marker buffer **36**, and FIG. **6G** [is of] *illustrates* the control word CW(i) from control word buffer **37**.

Encrypted marker EM(i) is included in the transmitted bit strips.

The transmitted bit strips including encrypted marker EM(i) [is] *are* formed as shown in FIG. **6A**, which is supplied to marker detector **31** to detect encrypted marker EM(i) to be supplied to marker decoder **33**. Also, marker detector **31** generates marker detection flag signal m-det-flag for informing of the position of [the encrypted marker at] the encrypted marker EM(i) [portion] as shown in FIG. **6B**, so that the generated signal is supplied to marker inserter **32** together with the bit strips including encrypted marker EM(i). Also, marker detection flag m-det-flag is supplied to descrambler **24** to be utilized as the reference signal for initializing descrambler **24** by control word CW(i–1) from control word buffer **37**.

Encrypted marker EM(i) is decrypted by the encoding key in marker decoder **33** [to be] *and is* supplied as decrypted marker M(i).

Decrypted marker M(i) is analyzed in marker analyzer **34** to determine whether the copy is permitted or not. In other words, marker analyzer **34** compares the CP information within decrypted marker M(i), i.e., the allowable generational field with the current generational field, *and determining* to permit the copy when the allowable generational field is not below the current generational field.

When the copy is permitted [as above], marker analyzer **34** slightly delays control word CW(i), which is a part of

decrypted marker M(i), to be supplied to control word buffer **37**, as shown in FIG. **6**C. At this time, marker analyzer **34** [provide] *provides* the control signal to marker updating/encoding unit **35** to control the updating of the marker.

That is, marker decoder **33** [form] *forms* decrypted marker M(i) from encrypted marker EM(i) after [delaying] a *delay* time required for the decode, and *the marker analyzer 34* generates control word CW(i) from decrypted marker M(i) [in marker analyzer **34**].

At this time, control word CW(i) is transmitted to control word buffer **37** to be stored until it is utilized in descrambler **24**.

Decrypted marker M(i) from marker decoder **33** is updated in accordance with the control signal from marker analyzer **34** in marker updating/encoding unit **35**.

That is, the updated data is the data recorded on the current generational field within the marker, which is obtained by adding one to the previously recorded current generation.

The marker updated as described above is encrypted, i.e., encoded, in accordance with the [encoded] *encoding* key to be supplied to marker buffer **36** as shown in FIG. **6**D, slightly delayed with respect to control word CW(i) from marker analyzer **34** as shown in FIG. **6**C. In more detail, the encrypted marker M(i) from marker decoder **33** is supplied to marker updating/encoding unit **35** to be generated as marker IEM(i), which is updated and encrypted after [delaying the] *a delay* time required for the encoding [to be], *and marker IEM(i) is* supplied to marker buffer **36**.

Here, the point of generating updated and encrypted marker IEM(i) and control word CW(i) from marker updating/encoding unit **35** and marker analyzer **34** does not coincide with a point of utilizing updated and encrypted marker IEM(i) and control word CW(i) in marker inserter **32** and descrambler **24**, i.e., the points of performing the replaceable insertion and initialization of descrambler **24** do not coincide with each other. Thus, updated and encrypted marker IEM(i) and control word CW(i) from marker updating/encoding unit **35** and marker analyzer **34** are temporally stored in marker buffer **36** and control word buffer **37** for that time.

As shown in FIG. **6**E, updated and encrypted marker IEM(i) temporally stored in marker buffer **36** and synchronized to be output is inserted by marker inserter **32** [to] *into* the bit strips from marker detector **31**.

In more detail, marker inserter **32** receives the bit strips having encrypted marker EM(i) and marker detection flag signal m-det-flag from marker detector **31**, and receives updated and encrypted marker IEM(i) which will be replaceably inserted [to] *into* the position of encrypted marker EM(i) from marker buffer **36**, so that updated and encrypted marker IEM(i) is replacably inserted to the position of marker detection flag signal m-det-flag in the transmitted bit strips including encrypted marker-EM(i) as shown in FIG. **6**E.

In other words, marker inserter **32** inserts updated and encrypted marker IEM(i) from marker buffer **37** replacing encrypted marker EM(i+1) at the position of producing marker detection flag signal m-det-flag.

Here, the replacably inserted marker IEM(i) is formed from the immediately detected preceding encrypted marker. Accordingly, as shown in FIG. **6**E, the marker IEM(i) is stored in marker buffer **37** for a certain period [to be] *and then* provided to marker inserter **32**.

As shown in FIG. **6**F, control word CW(i−1) *is* temporally stored in control word buffer **37** to be synchronized prior to being output *and* is utilized for descrambling the transmitted bit strips from marker inserter **32** in descrambler **24**.

At this time, descrambler **24** uses marker detection flag signal m-det-flag from marker detector **31** as the reference signal for initializing *based on* control word CW(i−1) from control word buffer **37**.

More specifically, descrambler **24** must be initialized by control word CW(i−N) from control word buffer **37** during a period from the point of generating encrypted marker EM(i), i.e., from a position of detecting marker detecting flag signal m-det-flag to the point before starting payload of a transport packet, where N is a natural number greater than zero. Here, control word CW(i−N) is a control word formed from encrypted marker EM(i−N) transmitted before encrypted marker EM(i) as many as N *times*. The natural number 'N' allows for arbitrarily controlling the initializing point of descrambler **24**.

In the copy prevention method and apparatus of the digital [magnetic] recording/reproducing system according to the present invention as described above, a program supplier can select the copy prevention function, and the field defined within a GA format is utilized. As the result, a separate format transformation apparatus for the copy prevention function is not required, and there is no increase in data amount to be recorded to perform the copy prevention function without converting, *for example,* the general digital VCR.

While the present invention has been particularly shown and described with reference to particular embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A copy prevention method of a digital magnetic recording/reproducing system comprising:

an audio and video signal transmitting process of encrypting a marker formed by a control word for scrambling audio and video bit strips and copy prevention information for preventing an illegal copy by means of an encoding key, and multiplexing said marker with said audio and video bit strips scrambled by said control word, and

an audio and video signal receiving/recording process of detecting said marker from said transmitted bit strips, decrypting and analyzing the detected marker by means of [an encoded] *said encoding* key to determine whether copy is permitted or not, updating said detected marker to be recorded on a video tape, and generating said control word from said marker to perform a descrambling and supply the audio and video signals to be displayed on a monitor.

[**2**. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim **1**, wherein said marker is placed on a transport-private-data field within said bit strips.]

3. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim [**2**] *1*, wherein said marker is comprised of a copy prevention information area recorded with said copy prevention information for preventing said illegal copy, and a control word area recorded with said control word for descrambling.

[**4**. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim **3**, wherein said marker is formed of 8 bytes.]

[**5**. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim **4**, wherein said copy prevention area is formed of one byte.]

[6. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 4, wherein said control word area is formed of four bytes.]

7. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 3, wherein said copy prevention information is formatted by including a generational copy control field for restricting the number of permitting said copy of a program.

8. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 7, wherein said generational copy control field comprises:

an allowable generational field for restricting the copy number of said program; and

a current generational field representing a current generation of a duplicated program.

9. A copy prevention-method of a digital magnetic recording/reproducing system as claimed in claim 1, wherein said audio and video transmitting process comprises:

an audio and video bit-strip encoding step of encoding said audio and video bit strips;

a control word generating step of generating said control word for scrambling;

a scrambling step for scrambling said encoded audio and video bit strips by means of said generated control word;

a copy prevention information generating step of generating said copy prevention information for preventing said illegal copy;

a marker generating and encrypting step of generating said marker by means of said generated control word and copy prevention information and encrypting said marker by means of said [encoded] *encoding* key; and

a multiplexing and transmitting step of multiplexing to transmit said scrambled audio and video bit strips and encrypted marker.

10. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 1, wherein said audio and video signal receiving/recording process comprises:

a marker detecting step of demultiplexing said transmitted bit strips to detect said marker, and decrypting said marker by means of said [encoded] *encoding* key;

a marker analyzing step of analyzing said detected marker to determine whether said copy is permitted or not, and detecting said control word;

an audio and video decoding step of descrambling and decoding said transmitted audio and video bit strips by means of said detected control word, and outputting said audio and video signals; and

a marker inserting step of updating said detected marker and encrypting said updated marker by means of said [encoded] *encoding* key to insert the result when it is determined that said copy is permitted after analyzing said marker.

11. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 10, wherein said marker analyzing step comprises:

a copy prevention information detecting step of detecting said copy prevention information for preventing said illegal copy from said detected marker;

a copy number restricting step of comparing an allowable generation of said allowable generational field and a current generation of said current generational field representing said current generation for restricting the number of permitting said copy of said program within said detected copy prevention information, and determining whether said copy is permitted or not-to process the result; and

a control word detecting step of detecting said control word for descrambling from said detected marker.

12. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 11, wherein said copy number restricting step comprises:

comparing said allowable generation of said allowable generational field with said current generation of said current generational field to determine whether said allowable generation is below said current generation;

inhibiting said copy when it is determined that said allowable generation is below said current generation; and

permitting said copy when it is determined that said allowable generation is-not below said current generation, and proceeding to said marker inserting step.

13. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 12, wherein said step of inhibiting said copy is performed by destructing said control word or impeding an output of said control word to block a reproduction after recording.

14. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 10, wherein said control word is periodically changed.

[15. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 14, wherein said control word is changed in the interval of 0.6 second.]

[16. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 14, wherein said marker is placed on said transport-private-data field within said bit strips whenever said control word is changed.]

17. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim [16] *14*, wherein said marker inserting step comprises the steps of:

updating said marker when the analysis of said marker determines to permit said copy;

encrypting said updated marker by means of said [encoded] *encoding* key; and

replacably inserting said encrypted marker with a succeeding marker.

18. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 1, wherein said [encoded] *encoding* key is transported via a separate transmission line to be stored.

[19. A copy prevention method of a digital magnetic recording/reproducing system as claimed in claim 18, wherein said encoded key is transported via said separate transmission line for a prescribed time interval.]

20. A copy prevention apparatus of a digital magnetic recording/reproducing system comprising:

an encrypted marker detecting and inserting part for detecting a marker from input bit strips, and inserting an updated marker to said bit strips to output the result;

a marker analyzing and processing part for decrypting and analyzing the encrypted marker from said marker detecting and inserting part by means of an [encoded] *encoding* key, outputting a control word for descrambling said bit strips, and updating and encrypting the decrypted marker by means of said [encoded] *encoding* key to output the result;

a buffer part for buffering said control word and updated and encrypted marker from said marker analyzing and processing part, and inserting said updated and encrypted marker in said marker detecting and inserting part; and

a descrambler for descrambling said bit strips provided via said marker detecting and inserting pant by means of said control word from said buffer part.

21. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **20**, wherein said **[**encoded**]** *encoding* key is transported via a separate transmission line to be stored.

[22. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **21**, wherein said encoded key is transported via said separate transmission line for a prescribed time interval.**]**

[23. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **20**, wherein said marker is placed on a transport-private-data field within said bit strips whenever said control word is changed.**]**

24. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **[23]** *20*, wherein said marker is comprised of a copy prevention information area recorded with **[**said**]** copy prevention information for preventing said illegal copy, and a control word area recorded with said control word for descrambling.

[25. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **24**, wherein said marker is formed of 8 bytes.**]**

[26. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **25**, wherein said copy prevention area is formed of one byte.**]**

[27. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **25**, wherein said control word area is formed of four bytes.**]**

28. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **24**, wherein said copy prevention information is formatted by including a generational copy control field for restricting the copy number of a program.

29. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **28**, wherein said generational copy control field comprises:

an allowable generational field for restricting the number of permitting the copy of a program; and

a current generational field representing a current generation of a duplicated program.

30. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **20**, wherein said control word is periodically changed.

[31. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **30**, wherein said control word is changed in the interval of 0.6 second.**]**

[32. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **30**, wherein said marker is placed on a transport-private-data field within said bit strips whenever said control word is changed.**]**

33. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **30**, wherein said marker detecting and inserting part replacably inserts said updated marker with a succeeding marker.

34. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **20**, wherein said marker detecting and inserting part comprises:

a marker detecting section for detecting to output said encrypted marker from said input bit strips to said marker analyzing and processing part, outputting a marker detection flag signal for informing of the position of said encrypted marker within said bit strips to said descrambler to be used as a reference signal of initializing said descrambler, and outputting said bit strips; and

a marker inserting section for inserting said updated and encrypted marker from said buffer part to said bit strips from said marker detecting section in accordance with said marker detection flag signal from said marker detecting section to output the result to said descrambler.

35. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **24**, wherein said marker analyzing and processing part comprises:

a marker decoding section for decrypting said encrypted marker from said marker detecting and inserting part by means of said **[**encoded**]** *encoding* key;

a marker analyzing section for analyzing said copy prevention information within said marker from said marker decoding section, and outputting said control word to said buffer part and a control signal for updating said marker when said copy is permitted; and

a marker updating and encoding section for updating said marker from said marker decoding section in accordance with said control signal from said marker analyzing section, and encrypting said updated marker by means of said **[**encoded**]** *encoding* key to output the result to said buffer part.

36. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **35**, wherein said marker analyzing and processing part further comprises an **[**encoded**]** *encoding* key storage section for storing said **[**encoded**]** *encoding* key to output it to said marker analyzing section and marker updating and encoding section.

37. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **35**, wherein said marker analyzing section compares an allowable generation of an allowable generational field with a current generation of a current generational field representing a current generation of a duplicated program to determine whether said copy is permitted or not.

38. A copy prevention apparatus of a digital magnetic recording/reproducing system as claimed in claim **20**, wherein said buffer part comprises:

a marker buffer for temporally storing said updated and encrypted marker from said marker analyzing and processing part, and outputting the result to said marker detecting and inserting part; and

a control word buffer for temporally storing said control word from said marker analyzing and processing part, and outputting the result to said descrambler.

39. A method of copy protecting digital data, comprising:

generating copy prevention information;

generating control data;

scrambling digital data based on said control data such that said control data controls a parameter of said scrambling operation;

forming a marker, said marker including said copy prevention information and said control data; and

transmitting said scrambled digital data and said marker.

40. The method of claim 39, further comprising:

combining said scrambled digital data and said marker; and wherein said transmitting step transmits output from said combining step.

41. The method of claim 40, wherein said combining step periodically multiplexes said marker into said scrambled digital data.

42. The method of claim 39, further comprising:

encrypting at least said control data.

43. The method of claim 42, wherein said encrypting step encrypts said control data based on a key.

44. The method of claim 39, wherein said distal data includes audio and video data.

45. The method of claim 39, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

46. The method of claim 39, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

47. The method of claim 39, wherein said generating a control data step periodically changes said control data.

48. The method of claim 39, wherein said scrambling step comprises:

initializing a scrambler using said control data.

49. The method of claim 39, further comprising:

generating identification information indicating that said marker includes data for copy protection; and wherein

said transmitting step transmits said digital data, said identification information and said marker.

50. A method of copy protecting digital data, comprising:

generating copy prevention information;

generating control data;

scrambling digital data based on said control data such that said control data controls a parameter of said scrambling operation;

forming a marker, said marker including said copy prevention information and said control data; and

recording said scrambled digital data and said marker.

51. The method of claim 50, further comprising:

encrypting at least said control data.

52. The method of claim 51, wherein said encrypting step encrypts said control data based on a key.

53. The method of claim 51, wherein said encrypting step encrypts said marker.

54. The method of claim 50, further comprising:

combining said scrambled digital data and said marker; and wherein

said recording step records output from said combining step.

55. The method of claim 54, wherein said combining step multiplexes said marker and said scrambled digital data.

56. The method of claim 54, wherein said combining step periodically multiplexes said marker into said scrambled digital data.

57. The method of claim 50, wherein said digital data includes audio and video data.

58. The method of claim 50, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

59. The method of claim 50, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

60. The method of claim 50, wherein said generating a control data step periodically changes said control data.

61. The method of claim 50, wherein said scrambling step comprises:

initializing a scrambler using said control data.

62. The method of claim 50, further comprising:

generating identification information indicating that said marker includes data for copy protection; and wherein

said recording step records said digital data, said identification information and said marker.

63. A method of processing copy protected digital data in a digital data processing apparatus, comprising:

receiving scrambled digital data and a marker, said marker including copy prevention information and control data, said control data controlling a parameter of a descrambling operation for descrambling said scrambled digital data; and

performing a copy prevention function based on said copy prevention information.

64. The method of claim 63, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

65. The method of claim 63, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

66. The method of claim 63, further comprising:

descrambling scrambled portions of said digital data for monitoring based on said control data.

67. The method of claim 63, wherein

said receiving step receives said marker encrypted; and further including,

detecting said encrypted marker in said digital data, said encrypted marker including said copy prevention information and control data;

decrypting said detected marker; and

descrambling scrambled portions of said digital data for monitoring based on said control data.

68. The method of claim 63, wherein said receiving step receives said digital data reproduced from a digital recording medium.

69. The method of claim 63, wherein said performing step comprises:

determining from said copy prevention information whether copying is permitted;

updating said copy prevention information if said determining step determines that a copy is permitted;

inserting said updated copy prevention information in place of said copy prevention information only in said digital data for recording if said determining step determines that a copy is permitted; and

recording output from said inserting step.

70. The method of claim 63, wherein the receiving step further receives identification information indicating that said marker includes data for copy protection.

71. A copy protected recording medium having a data structure for controlling operation of a descrambler in a reproducing device, comprising:

a digital data area storing scrambled digital data; and

a marker area storing a marker, said marker including copy prevention instructions and control data, said control data controlling a parameter of a descrambler descrambling said scrambled digital data.

72. The copy protected recording medium of claim 71, further comprising a plurality of periodically located marker and digital data areas.

73. The copy protected recording medium of claim 71, wherein at least said control data is encrypted.

74. The copy protected recording medium of claim 71, further comprising:

an identification area preceding said marker area and storing identification information indicating that said marker includes data for copy protection.

75. The copy protected recording medium of claim 71, wherein said copy prevention instructions indicate a number of times said scrambled digital data can be copied.

76. A apparatus for copy protecting digital data, comprising:

a copy prevention generator generating copy prevention information;

a control data generator generating control data;

a scrambler scrambling digital data based on said control data such that said control data controls a parameter of said scrambling operation;

marker forming means for forming a marker, said marker including said copy prevention information and said control data; and

a transmitting unit transmitting said scrambled digital data and said marker.

77. The apparatus of claim 76, further comprising:

combining means for combining said scrambled digital data and said marker; and wherein

said transmitting unit transmits output from said combining means.

78. The apparatus of claim 76, further comprising:

an encrypting unit encrypting at least said control data.

79. The apparatus of claim 78, wherein said encrypting unit encrypts said control data based on a key.

80. The apparatus of claim 76, wherein said digital data includes audio and video data.

81. The apparatus of claim 76, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

82. The apparatus of claim 76, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

83. The apparatus of claim 76, wherein said control data generator periodically changes said control data.

84. The apparatus of claim 76, wherein said scrambler is initialized based on said control data.

85. The apparatus of claim 76, further comprising:

an identifier generator generating identification information indicating that said marker includes data for copy protection; and wherein

said transmitting unit transmits said digital data, said identification information and said marker.

86. An apparatus for copy protecting digital data, comprising:

a copy prevention generator generating copy prevention information;

a control data generator generating control data;

a scrambler scrambling digital data based on said control data such that said control data controls a parameter of said scrambling operation;

marker forming means for forming a marker, said marker including said copy prevention information and said control data; and

a recording unit recording said scrambled digital data and said marker.

87. The apparatus of claim 86, further comprising:

an encrypting unit encrypting at least said control data.

88. The apparatus of claim 87, wherein said encrypting unit encrypts said control data based on a key.

89. The apparatus of claim 86, further comprising:

combining means for combining said scrambled digital data and said marker; and wherein

said recording unit records output from said combining means.

90. The apparatus of claim 86, wherein said digital data includes audio and video data.

91. The apparatus of claim 86, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

92. The apparatus of claim 86, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

93. The apparatus of claim 86, wherein said control data generator periodically changes said control data.

94. The apparatus of claim 86, wherein said scrambler is initialized based on said control data.

95. The method of claim 94, further comprising:

an identifier generator generating identification information indicating that said marker includes data for copy protection; and wherein

said recording unit records said digital data, said identification information and said marker.

96. An apparatus for processing copy protected digital data, comprising:

receiving scrambled digital data and a marker, said marker including copy prevention information and control data, said control data controlling a parameter of a descrambling operation for descrambling said scrambled digital data; and

a copy prevention means for performing a copy prevention function based on said copy prevention information.

97. The apparatus of claim 96, wherein said copy prevention information includes at least current generation information indicating a number of times said digital data has been copied.

98. The apparatus of claim 96, wherein said copy prevention information includes at least allowable generation information indicating a number of permitted copies of said digital data.

99. The apparatus of claim 96, further comprising:

a descrambler descrambling scrambled portions of said digital data for monitoring based on said control data.

100. The apparatus of claim 96, wherein

said receiving unit receives said marker encrypted, detects said encrypted marker in said digital data;

said analyzing unit decrypts said detected marker; and further including,

a descrambler descrambling scrambled portions of said digital data for monitoring based on said control data.

101. The apparatus of claim 96, wherein said copy prevention means comprises:

an analyzing unit determining from said copy prevention information whether copying is permitted, and updating said copy prevention information if a copy is permitted;

an inserting unit inserting said updated copy prevention information in place of said copy prevention information only in said digital data for recording if a copy is permitted; and

a recording unit recording output from said inserting unit.

102. The method of claim 96, wherein the receiving unit further receives identification information indicating that said marker includes data for copy protection.

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